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[OFFICIAL NOTICE.]

New England Association of Gas Engineers.

The next Semi-Annual Meeting and excursion of the Association, with their ladies and friends, will be held at North Adams, Mass., on the 18th and 19th days of August next. Headquarters at the Wilson House.

GEO. B. NEAL,
Secretary.

BOSTON, July 10, 1880.

GAS ENGINEERING.

At the recent meeting of the American Society of Civil Engineers, held at St. Louis, Mo., the President's address, upon the progress of Engineering in the United States, alludes as follows to the subject of Gas Engineering—

[The address was prepared by Mr. O. Chanute, Vice-President of the Society, owing to the absence of the President in Europe.]

GAS ENGINEERING.

Another department of engineering represented in this Society, has for its object the construction and management of works devoted to the manufacture of illuminating gas.

In 1850 there were only about fifty gas light companies in the United States. In the thirty years which have elapsed since that time, the number of companies has increased to nearly nine hundred, with a capital aggregating more than two hundred millions of dollars. The amount of gas annually manufactured for illuminating purposes is probably not less than twenty thousand millions of cubic feet. The magnitude of the business may, perhaps, be better comprehended from the statement that this entails the mining, transportation, handling and carbonizing of something over two millions of tons of coal per annum.

The gas makers, however, unlike railroad managers, have not until recently been compelled, by sharp competition, to study close economy, but the pressing demand for a reduction in the price of illuminating gas to the consumer is, to-day, necessitating the application of scientific education in all the departments of its manufacture.

The improvements that have been made thus far have consisted mainly in the setting of the retorts, and in more efficient condensation and purification. The competition brought about by the introduction of other illuminating agents is compelling the attention of engineers to the application of machinery, in the various operations involved in gas making, for the purpose of reducing the cost of labor, and also to developing the useful application of the various residual products, which result from gas manufacture.

In other countries than the United States, particularly in England and France, the value of these residual products, together with the lower price of labor and material has enabled the companies to reduce the price of their gas much below the point at which it can be profitably sold in this country. In the city of London the sale of residual products returns to the companies sixty-six per cent. of the cost of their coal. When the demand for these products increases to that extent in this country, a very decided reduction of the price of gas to the consumer can be made without reducing materially the profits of the companies.

The most recent application of the results of scientific investigation consists in the introduction of gas furnaces, and of mechanical means for charging and discharging the retort.

In gas furnaces very decided success has been reached not only by foreign engineers but by engineers in this country. The efforts that have been made in mechanical stoking, have heretofore resulted only in partial success but within the last year a machine has been invented and put into practical operation in the city of Cincinnati, which bids fair to accomplish the desired result.

Much attention has been paid of late to what is called water gas, which consists, in principle, of the decomposition of steam by means of incandescent fuel, the resulting products of which are carburetted with petroleum to give it illuminating qualities. Claims of superior cheapness have been made

by the promoters of this process, while coal gas makers claim that gas can be made from coal as cheaply as by any of the water gas processes. As the latter have been largely introduced in some places, time will undoubtedly show which party is entitled to the greatest amount of credence, but as yet by far the largest proportion of illuminating gas sold in this country is made from coal.

Suffocation by Coal Gas.

EDINBURGH, SCOTLAND, July 2, 1880.

I observe in your Journal, of 16th ult., a note of the personal experience of one who was "overcome by gas." I once had similar experience, and during the continuance, to outward appearance, of utter insensibility, I was quite cognizant of the remarks of those who were anxiously endeavoring to rouse me to consciousness.

My foreman at the works then under my charge, following instructions I had previously given him in dealing with such cases, administered a large wine glassfull of water containing about a tea-spoon of sal volatile, by which, as a stimulant, the prostrated animation was quickly restored, and within an hour or two the effects of the gas suffocation passed away, leaving a slight headache.

During an experience of many years in a large gas works, I found that a traditional method of dealing with gas suffocation, one existing years before my time, was the application of considerable and potent doses of whiskey which, in most cases, was followed by recovery; and a stock of whiskey being kept always at hand, I began to think, from the frequency of cases requiring whiskey, that the medicine had something to do with the number of gas suffocation cases.

I consulted a skilled medical friend, who suggested the application of sal volatile, and I am glad to avouch for its essential efficacy in restoring suspended animation from the cause referred to, and also as a preventive, for, certainly, the abandonment of the whiskey cure in favor of the ammonia spirit reduced the average number of cases by 50 or 60 per cent. It might be worth trying on your side of the water.

AN OLD SCOTTISH GAS MANAGER.

New England Association of Gas Engineers.

The following is the programme for the Summer Meeting of this Association:

The next Semi-Annual Meeting and Excursion of the members of the Association, with their ladies and friends, will occur on the eighteenth and nineteenth days of August, 1880, at North Adams, Mass., a programme of which is hereto annexed:

Members are permitted, by vote of the Directors passed at their last meeting, to invite, in addition to the ladies, officers of gas companies and gentlemen furnishing machinery and supplies for such companies.

Tickets from Boston to North Adams, via the Hoosac Tunnel and return, can be obtained of the committee, either before or on the morning of the 18th of August, for $4 each, (regular fare $8.50.) Board at the Wilson House, North Adams, including banquet at Greylock Hall, at the rate of $2.50 per day. Comfortable mountain carriages for the rides named in the programme, capable of seating eighteen persons, will be furnished for $1 a seat for each trip. Carryalls for four persons, with two horses, $5 each trip. Single teams, for two persons, $2.50 each trip.

The Committee would have been pleased to have made arrangements for transportation from other parts of New England and elsewhere, at commuted rates, but were unable to do so. The place of meeting will be found to be easily accessible from the residences of those proposing to attend the same, who cannot avail themselves of the arragements made by the committee for starting from the Fitchburg Railroad Station in Boston, and they are respectfully referred to the time tables of the several railroads communicating between their respective places of residence and North Adams.

The great success of the last semi-annual meeting and excursion, at which the ladies were present for the first time on an occasion of the kind, has encouraged the Committee to make extensive arrangements for the coming occasion; and they confidently expect, not only a full attendance of the members with their friends, but also a large gathering of the ladies.

The novelty of passing in a railway car nearly five miles through the bed of a mountain; the delightful rides arranged for in the programme, which will bring to view the magnificent scenery around North Adams; the elevated position of Greylock Hall, on a slope of Greylock Mountain, commanding a most extensive and charming landscape; and the rare opportunity of meeting and exchanging views with members of the profession from New England and other places, are sufficient attractions, in the opinion of the Committee, to induce every member to make unusual exertions, and to forego all ordinary engagements in order to be present.

The Committee emphatically request all those receiving this circular to notify the Secretary, on or before the 14th day of August next, whether they propose to attend the meeting or not.

Those intending to take the train on the morning of the 18th of August, at the Fitchburg Railroad Station, Boston, will please inform the Secretary of the fact.

GEORGE B. NEAL,
Secretary.

L. P. GEROULD,
JOHN ANDREW,
GEO. B. NEAL. } *Committee of Arrangements.*

BOSTON, July 6, 1880.

Programme, Wednesday, August 18.

8:30 A.M.—Leave Fitchburg Railroad Station, Boston, for North Adams, via. Hoosac Tunnel.

1:05 P.M.—Arrive at North Adams. Short walk to Wilson House from Depot.

2 P.M.—Dinner at Wilson House.

4 P.M.—Ride to East Summit of Hoosac Mountain and back.

7 P.M.—(Or upon return from ride) Tea.

8 P.M.—Business meeting of the Association.

Thursday, August 19.

7 to 8 A.M.—Breakfast.

9 A.M., PROMPTLY.—Ride through Williamstown to Greylock Hall.

1 P.M.—Banquet at Greylock Hall.

3 P.M.—Leave for Wilson House.

4:35 P.M.—Take train for Boston, via Hoosac Tunnel.

Book Notices.

Science, a new weekly journal of scientific progress, has just made its appearance. No. I., Volume I., presents a very neat and convenient form of periodical which, if its design, as expressed by itself, is adhered to, will make it a very valuable paper.

"'*Science*' occupies a field in periodical literature hitherto unoccupied, and is the only first class weekly journal in the United States, devoted to science, recognized by scientists as their medium of communication.

"To all who desire to keep *au courant* with the progress of Science, this Journal will be found invaluable. If is offered in a size convenient for binding, and will form two annual volumes with good indexes, replete with original articles by the most eminent scientists, and as a standard work of reference on scientific subjects should find a place in every library and household.

"The list of Associate Editors is not yet complete, but so far it comprises the names of professional scientists in the various branches of science with which they have identified themselves."

The Manufacture of Coal Tar Dyes.

The extent to which the manufacture of coal tar colors is now carried is shown by the following statistics of labor and production at one of the principal coal tar color works in Germany:

There are employed over 1,000 workmen, in addition to 40 overlookers and branch managers, twenty-five chemists, one engineer, and thirty clerks and accountants. The yearly consumption of coal amounts to 17,000,000 kilos; anthracene, 825,000 kilos; naphtha and benzole, 950,000; chromate of potash, 280,000; caustic soda, 1,245,000; sulphuric acid, 2,250,000; muriatic acid, 4,050,000; nitric acid, 825,000; alcohol, 91,500; and sundry chemicals, 3,560,000.—*Sci. Am.*

Phosphorescence of the Glow-worm.

Jousset de Bellesme has repeated the experiments of Matteucci upon the glow-worm with some precautions which lead him to more satisfactory results. He removed the cephalic ganglia so as to destroy all voluntary phosphorescence, and substituted the passage of a moderate electric current through the body, or in the luminous organ, thus producing a brilliant phosphorescence. When the insect thus prepared was plunged into carbonic acid, or into either of the inert gases nitrogen and hydrogen, the electric excitement produced no light.—*Les Mondes.*

NEW USE OF NICKEL.—Nickel is more infusible than iron, more malleable, more ductile, tougher, and not affected by atmospheric influences. M. Fleitman has found that when melted it absorbs some carbonic acid, and if a small quantity of magnesium is then added the metal becomes remarkably ductile and malleable. It can be drawn out into very fine wire or beaten into extremely thin leaves, and can be readily welded either to nickel or iron. —*Chron. Ind.*

[From the "London Journal of Gas Lighting."]

Seventeenth Annual Meeting of the British Association of Gas Managers.

INAUGURAL ADDRESS OF THE ACTING PRESIDENT, CHARLES HUNT, ESQ., OF BIRMINGHAM.—Delivered Tuesday, June 8, 1880.

Gentlemen:—The circumstances under which I have to ask for more than the usual measure of that indulgence and support which have been so freely accorded to every former occupier of this chair are fully known to you. It has unfortunately happened that the President of your choice has been compelled by persistent ill health, in the midst of his term of office, to return into your hands the dignity conferred upon him. Our regret at the necessity for such a step remains profound; and I am sure that you will wish me to convey thus publicly to Mr. Douglass the assurance of your sympathy, and of your earnest wishes for his speedy and complete recovery and future prosperity.

As you are doubtless also aware, our esteemed Secretary, Mr. Bennett, has during the last few months been laid prostrate by a seriour illness, from which he is happily to a considerable extent restored. While congratulating him upon his recovery thus far, we have it in our power to testify, in the most practical manner possible, to our regard for one to whose exertions the Association is so greatly indebted, by assisting in the work of this meeting when assistance would be of service, and by the exercise of as much forbearance as possible during the continuance of it.

During the past year we, as an Association, have lost through death five of our number. These are—Mr. George Berry, formerly and for many years Manager of the Ashford Gas Works, in Kent; Mr. A. F. Livesay, formerly part proprietor of and otherwise officially connected with the Ventnor Gas Works, Isle of Wight; Mr. F. W. Brothers, late Manager of the Chorley Gas Works; Mr. H. S. Pierson, formerly Inspector of Mains, in the service of the Chartered Gas Company; and Mr. Claudio Gil, of the Gas Works, Barcelona; all of them most worthy representatives of the profession to which they belonged.

It is fitting here to record also the death of one who, although not a member of the Association, yet took a warm interest in its welfare, as in every thing connected with the gas industry. It was only last year that we had to lament the loss of the familiar reporter of our proceedings, and now the keen yet kindly critic has gone from among us. Mr. T. W. Fewtrell, F.C.S., whose death we now deplore, took for several years an active part in the management of the *Journal of Gas Lighting*, succeeding, in a great measure, the late Mr. T. G. Barlow. His intimate knowledge of chemistry rendered his criticisms upon the subject of gas manufacture of especial value; although his name will probably be held in remembrance chiefly as co-editor of Mr. Newbigging of "King's Treatise on Coal Gas," the most valuable and comprehensive work of the kind yet attempted.

If the present total number of members be compared with that for the year 1870, when it was 314, it will be seen that the Association has considerably more than doubled during the past ten years, proving it to be possessed of an amount of vitality greatly in excess even of that with which the manufacture of gas is ordinarily credited. Nor will it be found upon examination that its augmented usefulness suffers in comparison with this great accession to its numbers. Year after year fresh fields for investigation have been opened up, new problems have been presented for solution, until there is hardly a detail, intimate or remote, of the complex art of gas manufacture that has not been made the subject of free, exhaustive, and instructive criticism. Our discussions have made of individual knowledge common stock; our published transactions will be found to be a faithful reflex of, almost without exception, the most advanced opinions upon all technical matters relating to gas.

These annual gatherings afford to the gas manager more and more favorable opportunities for throwing off that crust of isolation by which he is apt to be enveloped, and for freeing himself of crudities that are so often engendered by a life of comparative self-dependence. It is not necessary that his voice should have been heard at these meetings; he may have been a mute participator in our proceedings; yet if he has not returned to his work improved by contact with his professional brethren, quickened in his desire to do the best that he can both in and for his calling, he will have proved himself to be insensible to one of the most powerful appeals that could be addressed to him. Such, in brief, has been the work of the Association, and such may it long continue to be.

My object, however, in thus referring to it is not one of laudation merely; there is, as may be readily imagined, a reverse side to this pleasing picture, which I conceive it to be equally my duty to place before you. Some there are among us who do not feel entire satisfaction at the past career of the Association, and who desire to mould its future more in accordance with their views of an enlarged sphere of usefulness. With these it is impossible not to feel a certain amount of sympathy. There can be but few who, looking back along the road they have traveled, have not to recall some opportunities disregarded, some aspirations unfulfilled. As with the individual, so it may also be with the Association.

It is objected that its aims have been metropolitan rather than cosmopolitan; its actions mechanical rather than progressive. Toward the satisfying of a growing desire on the part of members for more frequent opportunities of discussing matters of immediate importance, it has made no effort; and hence the formation of district associations; of sections, bound to it indeed by the strongest ties of sympathy, but owing to it no other allegiance than that which is secured to it by the force of superior numbers, position, and influence. In the conduct of its affairs it has adhered, without sensible variation, to its original programme; our annual volume, while increasing in bulk and, let me add, in value also, remaining what it was at the commencement—a report solely of the proceedings of two or at most three days in every year. There seems to be no good reason why, except perhaps on the ground of expense, this should not be made of still greater value to us all. Following the example of similar associations, it might, through the instrumentality of a Committee of Publication, be constituted a complete record of the progress of gas manufacture in all parts of the world. This would be accomplished by the selection, and translation where necessary, of such extracts from both British and foreign journals as might, in the opinion of the Committee, possess a permanent interest in relation to gas. In this way we should be kept informed semi-annually or oftener if found desireable, of the advances made in connection with gas lighting abroad, and at the same time be building up for ourselves an epitome, for reference, of the most valuable and comprehensive kind.

In another direction also it seems possible that we might with advantage imitate the practice of kindred societies—namely, in the encouragement and prosecution of original research. I am not unmindful of the fact that the Association has in its gift at least one medal, besides premiums at will, and that in the bestowal of these it is unlikely that the claims of the meritorious investigator could be overlooked; yet do we not fail somewhat in our aims by not giving, to a certain extent at least, point and direction to the labors of the latter, and by abstaining, in our collective capacity, from all attempts at elucidating some of the apparent mysteries of gas manufacture? Such, at any rate, are among the suggestions that occur for extending the usefulness of the Association; and I venture to hope they may not be deemed unworthy of your consideration.

Whatever of truth there may be in the saying that "London is not England," certain it is that its gas polity is reflected far and wide, possessing an interest extending beyond even the limits of the realm. Here was first made conspicuously apparent the failure of active competition when applied to gas undertakings; and here also, following within the space of a few brief years the rejection of this principle, was first accepted, in its most comprehensive sense, the very opposite one of amalgamation. It is not necessary to justify the combinations that have taken place, and of which we cannot yet have witnessed the last, by pointing to reductions of price that have followed, or are expected to follow; their advantage has been made apparent enough during the past few years by the disappearance from crowded neighborhoods of works that could not but be inconveniently and uneconomically conducted. The growing requirements of an overflowing population had, in fact, rendered amalgamation a necessity altogether apart from financial considerations; yet the concentration of manufacture in the most suitable localities thus made possible, must of itself, from its greater economy and the higher degree of skill that it admits of, have eventually secured great and lasting benefits to the consumers, had they only possessed what has been called the "magic of patience" to await its fruition.

Gas legislation, however, like Parliament itself, seems destined every few years to undergo a more or less complete revision; and in the fulness of time, albeit precipitated by events that need not now be recalled, it was considered desirable to stimulate the action of the companies toward further reductions in the price of their gas. The introduction of the sliding scale of dividend is recognized as having been mainly the work of one of our past-presidents, and now an honorary member—Mr. George Livesey; and it is an achievement of which he may justly feel proud. Without of necessity indorsing every argument that was advanced in support of so great a change, it may be accepted, at this distance of time, as the first, as it remains the only attempt to apply to what, in the hands of companies, are essentially commercial undertakings, sound commercial principles; and for this reason if for no other any effort to disturb it would be a matter for regret. Nevertheless it is to be apprehended that the public will regard with increasing jealousy augmentations of dividend for which only a bare justification can be shown to exist.

The permanence of the sliding scale as an institution depends, it may be said, upon its good behavior. It may be expected to continue in favor so long as it operates, or is believed to operate, more for the benefit of the consumer than the legislation it superseded; but it might quickly fall into

into disrepute upon the production of evidence of the superiority of the latter, or, in other words, if it could be shown to have retarded rather than have accelerated what might be called the natural progress of reduction. Whether in such an event the acquisition of the gas undertakings, in trust for the public, would be further promoted by parliamentary action, it is perhaps, notwithstanding the recent correspondence upon the subject, premature to consider.

Public attention has now for a lengthened period been directed to the claims of the electric light to be considered under its most recent aspects, as a rival to gas for the general purposes of illumination. Ever since the discovery, almost contemporaneously with gas lighting, of the conversion under certain conditions of electric energy into light, this possible means of illumination has attracted to itself the very highest scientific intelligence. For nearly the best part of a century the names of many of our most eminent men of science have been identified with efforts for its development and it is therefore not at all surprising that its advocates to-day are men upon whom we are proud to say have fallen the mantles of Faraday and of Davy. But what, it may be asked, is the position which has been secured for it, and what are the prospects with which it has been endowed? Have we any greater reason to fear in it a rival now than at any past period of our history? Are we entitled still to term it the ignis fatuus of modern philosphers, or has it, in the words of one of the most distinguished of these, after having been in dreamland for sixty years, now come into the world of realities? These are questions that concern our future, and although we may reasonably believe that in the main they are in course of practical settlement in favor of gas, yet a brief consideration of them may not seem altogether undesirable.

It is evident, then, that the electric lamp, for ordinary indoor purposes, has yet to be invented. Notwithstanding the sensational announcements that have from time to time been sent to us from across the Atlantic, no advance whatever has been made toward the adaptation of the light to domestic requirements. It is not, however, to be inferred from this, or from the many failures that have occurred, that therefore, in the present state of the science, the lighting up of moderately large interiors is impracticable. On the contrary, evidences of its practicability are of no recent date. As an example, I may recall to your remembrance the illumination, some time ago, of the Hippodrome, in Paris, than which anything of the kind more charming in its general effects it is difficult to imagine. The impression left upon my mind by that enormous building, flooded with light in every part, by the sea of faces, every lineament of which was, so to speak, distinctly visible, will not soon be effaced, and has reconciled me to much of the enthusiasm which the new light invoked.

The Paris Salon, also, has this season, and for the second time, been lighted up upon the Jablochkoff system, in a manner that has called forth a large measure of approbation. Many efforts in the same direction have likewise been made in this country—efforts, it is true, for the most part of brief duration, yet becoming more persistent and continuous; and, so far, illustrating the possibility of successful illumination.

There is no need to inquire too closely into the causes that in so many instances have led to the abandonment of experiments auspiciously commenced. These may have been various, but one that has been patent to all is the intolerable flickering and unsteadiness inherent in almost every lamp that has yet been introduced. As an instance of the extent to which this interferes with the efficiency of electric lighting, I may mention the results of some observations made not long ago, at my instigation, of the effect of a Jablochkoff "candle" in full combustion, placed within a clear glass lantern. These disclosed a rapid variation in the light afforded; the difference in the areas of illumination, many times repeated within the space of only two or three minutes, being represented by the proportion of 9 to 4; that is to say, that while the observer was able at one time to see to read at a distance of 203 feet from the lantern, almost immediately afterward the light became so contracted that he could only see to read the same print at a distance of 132 feet. This experiment was continued for some little time, and by three different observers, with practically the same results, although, as was to be expected, the distances arrived at by each were by no means the same. Within doors this defect has usually been overcome in a great measure by placing the lamps sufficiently close together to allow their circles of illumination to completely overlap; but so expensive a remedy is of itself an efficient barrier to the employment of any system depending upon it.

Much attention, however, continues to be given to a matter of such vital importance; and not long ago there was exhibited, among others, in this hall,* an improved form of lamp, the invention of a Mr. Crompton, which is said to combine steadiness with simplicity of action. This lamp it is understood, is already in use in Glasgow and other places, while the improvements that have been made in the Werdermann incandescent burner has secured for it a place among the competitors in the interesting trial that is about to be conducted at the Opera House in Paris. The Brush system has also been introduced into this country from America, where, according to report, it has met with considerable success, and has been applied, among other uses, to the lighting of underground workings. It is not easy for us to conceive of the adaptation of any system of electric lighting to such a purpose, but I need hardly say that we, of all sections of the community, are interested in the highest degree in all that concerns the safety and comfort of the miner, and are prepared to welcome with satisfaction and thankfulness any means by which they may be rendered more secure. So far, therefore, from grudging to electricity this field of usefulness, we would say to it in all sincerity, "Go on, and prosper."

The cost of production of the electric light per candle is, according to the most reliable evidence, so absolutely governed by the magnitude of the light evolved, and the ultimate value of the latter is so entirely dependent upon the use that can be made of it, that it seems impossible to arrive at any fixed notion in regard to it in comparison with that of gas. All that we know with any degree of distinctness is that its superior economy has never yet, unless for very special purposes, been demonstrated, either in this country or, I will venture to say, out of it.

It is true we have heard much, and are probably destined to hear more, of the cheapness of its production on a large scale, say in a 6000-candle lamp; but then it is apparent that in the application of such a powerful light all, and more than all, of the advantages of economical production may readily disappear. This in practice is found to be the case, and hence it is that systems producing lights of lesser magnitude continue to be preferred, although costing very much more, in consequence of, to use the words of Mr. Preece, the "terrific waste" of subdivision. It has, however, been claimed for these that, in their adaptation to the requirements of factories and other similar buildings, they possess an advantage over gas in the matter of cost; but here again there is little or no reliable data; and it will be found that in the majority of cases other reasons than that of economy have determined their adoption.

Such comparisons, too, as have been made, have invariably, and perhaps of necessity, been between the cost price of the one means of illumination and the selling price of the other, forgetful of the fact that in the same way might gas itself be proved to be cheaper than gas. It was only the other day, for instance, that I heard of a large manufacturer, having gas works of his own, who is making gas mainly for the sake of the coke that he produces, which is valuable to him in his manufacture, and with which it is evident that he is by no means overstocked. It is clear that his gas is costing him very much less than it would if he obtained his supply from the local authority or company; and this, although probably in a much less marked degree, is doubtless the position of many who prefer to be their own producers. But such experience by no means suggests the advisability of every consumer following the example of these economists; this impracticable alternative being very far removed by the development of a system that has hitherto remained unsurpassed for convenience and adaptability to the requirements of the greatest number.

What is really to be considered, then, is not so much whether electric lighting is or is not going to supersede gas in this large building or in that, or whether, for certain purposes, it may not find extended employment; but rather the possibility or otherwise of its expansion into a system at all comparable with our own. In this view our interest in the efforts of electricians continues to be centred almost wholly in the experiments upon the Thames Embankment, where alone has there been any practical attempt at determining the problem of distribution. This being a matter upon which so much of the future of electric lighting depends, the engineers in charge are justly entitled to the credit of having scored a considerable success in proving, as has been done during the past few months, the practicability of the transmission of the electric energy, without appreciable loss, to nearly twice the distance originally contemplated; although to us, who are accustomed to send our gas through systems of mains of hundreds of miles in length, it seems a very small matter indeed to make an extension of a few hundred yards or so.

The bolder spirits among the electricians, however, are at the present time meditating far loftier flights, calculated, in their opinion, to exalt electric lighting into the regions of economical science. Dr. C. W. Siemens, whose name has long been honorably associated with the progress of science and industry, both in this country and abroad, has proposed the transmission of electric energy on a scale far exceeding anything that has yet been attempted. He has arrived at the conclusion that a copper conducting rod, 2 inches in diameter, would suffice to convey 1000-horse power to a distance of 30 miles. We are not concerned as to the initial power that would be required to produce this effect, nor as to the means by which it would be obtained, whether by the agency of steam or by the subjugation of a waterfall. What interests us mostly is the indication the proposal affords of the possibility or otherwise of successful distribution in competi-

* Institution of Civil Engineers.

tion with coal gas. It is probable that such a conductor would not cost, in ordinary times, much less than £100,000, or, let us say, about that of a 24-inch gas main. There is, it is true, no precise parallel to such a length in gas distribution, the nearest approach to it being probably the case of the Beckton works, where it is understood the gas is transmitted to a distance of 15 miles before distribution; but our knowledge of the subject enables us to discuss such a project as one that is entirely within the bounds of practicability, and with regard to which a tolerably exact calculation can be made of the effect. Assuming, then, an initial pressure of, say, 6 inches, or that of most gasholders of any size, it will be found that a 25-inch main is capable of delivering to a distauce of 30 miles, and between two level points, a sufficient quantity of 17-candle gas for an effective illumination of about 220,000 candles, when consumed during one hour. On the other hand, the value of the 1000-horse power has to be variously estimated. If expended in conjunction with lamps of large power, which for ordinary purposes are simply impracticable, it may be said to represent an illumination of 1,200,000 candles; if applied to the more practicable Jablochkoff system, we should expect to get an available illumination of about 230,000 candles, or much the same as in the case of the gas. This, however, it may be fairly assumed, is the maximum effect to be expected from the copper conductor, whereas we know perfectly well that the rate of delivery through the gas main could, by means of common enough appliances, and at a very trifling cost, be enormously if not indefinitely increased, to say nothing of the accidental assis ance that might be afforded by rising ground.

Regarded, therefore, as merely a matter of transmission, and taking no account of the fact that the minimum delivery of the gas main would represent, if converted into power by the gas engine, more than three times the ultimate effect of the copper conductor, it is evident that gas lighting has nothing whatever to apprehend from the facility of conduction of electric energy as illustrated by the proposals of Dr. Siemens. So that, when we are threatened with a competition that is to brought about by the utilization of waste water power, we may confront dream with dream; ours not perhaps the least possible of realization, being of the time when the waste gases from innumerable coke ovens shall be collected, purified, and stored for the use of the nearest towns; or, further yet into the future, when gas manufactories on a gigantic scale shall be established in the heart of our principal coal fields, for the purpose of furnishing the means of light and heat to our great centres of population, in much the same way as the water supply is in course of being dealt with by the bold and sagacious projectors of the Thirlmere scheme.

While occupied in this way in observing the front of our position, a more potent, because a more insidious adversary claims attention in our rear. Considering all the advantages that gas lighting possesses and is able to offer, it may upon first thought appear a little absurd to describe the inconvenient oil lamp as a powerful competitor; and yet to this dignity must it be acknowledged that our apathy has too frequently raised it. Ever at hand to a very numerous class of consumers as a possible and cheap alternative, its manufacture has become an important, and continues to be an increasing industry, with an effect upon our own that cannot fail of being almost correspondingly opposite; so that, at a time when so much is being done to establish for gas new uses, it is important to inquire how far its primary use is restricted by the protective policy that is just now so much the fashion.

The returns that have been most kindly furnished me, and which I take this opportunity of acknowledging, reveal the fact that there is, in most towns, a very wide field for the employment of gas for illuminating purposes, untouched, because for the most part avoided, by gas enterprise. They showed that in 40 large towns, having populations of not less than 40,000, in which what is known as "common" gas is supplied, the consumption per head of population varies from 2000 to 4600 cubic feet per annum, the average being 3197 cubic feet, while the proportion of consumers to tenements differs more widely still, being, in the 20 towns respecting which I have been able to obtain complete returns, from 28 to 91 per cent., with an average of 59.25. In only two instances is the percentage more than 76, and in only 11 is it over 60.

It might be superficially assumed that these variations are the effect of population, price, or habits; but the returns make evident the existence of an influence more powerful than these. For example, there are two neighboring towns, similarly constituted, but one more than twice the size of the other, price and quality being much the same in both, in the smaller of which has been developed a consumption far exceeding per head of population that of the other, with a percentage of consumers actually more than double. In this instance a less generous treatment of the consumer in the larger town stands plainly enough in the way of an augmentation of business of fully 60 per cent. Again, in one very small non-manufacturing town, not included, on account of its size, with those I have just referred to, there is a percentage of consumers of 70, and a consumption per head of population of 3500 cubic feet; in striking contrast with a manufacturing town more than twelve times its size, in which the percentage is only 34, and the consumption 2500.

I do not know what may occur to you as a reasonable explanation of such an anomalous condition of things, but I believe I am in possession of a sufficient, although by no means a satisfactory one.

The fourth question in my circular was, "What is your rule with regard to deposits or guarantees?" and the answer to this from the smaller of these two towns was, "No deposit or guarantee." The other reply is to be interpreted as expressing considerable confidence in the principle of "money down," and a determination to uphold it; so that here are illustrated two distinct lines of policy, with their attendant results—the one founded upon ordinary business faith and business practice, the other upon suspicion and mistrust, probably without a parallel in the commercial world. There are, however, open to gas managers the famous "three courses." In addition to what may be called the repellant and the neutral, of which I have furnished examples, there is also the attracting.

At the head of my list stands a large manufacturing town, having 91 per cent. of consumers, and a consumption of a little over 4600 cubic feet per head of population. What is the reply in this case to question No. 4? I will quote a portion of it: "Cottages supplied under agreement with the landlord, who becomes responsible for payment of gas consumed by his tenantry, and on the aggregate he obtains a discount varying with the amount," etc. I need not follow my correspondent in the table of discounts that he has been kind enough to send me; that is a matter of detail less interesting than the principle involved, and the lesson we may derive from its application. This lesson I take to be that gas undertakings are not exempted from the conditions that govern the success of all commercial enterprises, except in so far as a beneficent Legislature has shielded them from the ill effects of a mischievous policy; but that liberality, combined with caution and sagacity, is sure to meet with a full reward, not only in the shape of assured profits, but also in the approbation of the customers; in short, that as we sow, so may we expect to reap.

It cannot, however, be said that either the possible or the actual rivalry to which I have referred, however at times they may have disturbed the serenity of the prospect, have hitherto affected our material prosperity. With very few exceptions the price of gas is at the present time lower than at any former period, while full dividends continue to be secured. Nor are there any indications of our being spoiled by success. On the contrary, there probably never was a time of greater activity for progress, if one is to judge from the number of what may be called "burning questions" that await solution. Prominent among the many subjects that are at the present moment engaging our attention may be enumerated the proper application of heat to the retorts, the principles that govern economical condensation, the substitution of machine for hand labor in the retort house, and the desirability, not to say the necessity, of measures for extending and popularizing the uses of gas.

The question of economy in the consumption of fuel is one that has never by any means pressed heavily upon the English gas maker. Fortunately for him and for England, fuel has continued, with rare exceptions, to be both cheap and abundant; so that, in many localities, the enforced production of coke has from time to time proved a source of considerable embarrassment. Even in places not unfavorably situated for its disposal the problem of how to get rid of it has been sadly debated, and various ingenious devices have been resorted to for the purpose of presenting it in a more attractive form to the consumer.

Under these circumstances it could hardly be surprising if economy were the exception rather than the rule, and that it is otherwise may be regarded as distinctly creditable to those who practice it. It is, however, quite conceivable that a striving after excellence in this particular may be carried too far, and that a liberal, but at the same time effective expenditure of fuel may after all turn out to be the truest economy. So, at least, would seem to be the opinion of our Continental and American brethren, for their settings have for years been worked at a temperature exceeding anything that has hitherto, except perhaps here and there, found favor in this country. They appear, in fact, to have made deleberate choice of increased production as against a low fuel account; their make per mouthpiece, with retorts of an ordinary size, being commonly from 7000 to 8000 cubic feet per diem, with an expenditure of fuel varying from 30 to 40 per cent. of the coke produced. If, then, as is to be reasonably inferred, this policy of high heats be successful with fuel at prices that we should consider excessive, what chance could it have of failure where fuel is a drug, seeing that it offers the double advantage of increased and profitable consumption and diminished production?

While, however, the principle itself is receiving but tardy recognition here, already the means by which its advantages have hitherto been secured are, in Germany at least, in a great measure superseded. The large combustion chamber, forming, as it were, the core of the German setting, is in most modern constructions giving place to the gas-producing furnaces of

Oechelhauser, Liegel, Grahn, and others. The idea of applying heat in a gaseous form to gas retorts is by no means new. It is now many years since Dr. Siemens proposed the employment of his regenerative furnaces for this purpose, and they were so applied in at least two English works. It is perhaps unnecessary to recall the circumstances that led to their ultimate abandonment in both instances; suffice it to say that their fuel economy was satisfactorily demonstrated. A trial of them made almost simultaneously at the Paris Gas Works proved more fortunate for their permanence; for there they have since, in a modified and improved form, been adopted in all extensions.

Those of us who have visited these works—and many availed themselves of the opportunity afforded them two years ago—are able to testify to the admirable heats maintained by this system—obtained, it is stated, with an economy over the solid fuel system sufficient to cover the extra cost of construction in one year and a half of constant work. It is not, however, easy to become reconciled to the somewhat elaborate application of the regenerative principle which forms so prominent a feature of the arrangement; and this, perhaps more than anything else, has hindered the general acceptance of this description of furnace.

However desirable the utilization of waste heat may be under all circumstances, it has never come to be regarded among us as an object of the first importance, or as one to be pursued to the exclusion or sacrifice of other considerations. The Germans, although under a greater necessity for economy in this respect than ourselves, have practically adopted the same view, by seeking, in their gas furnaces, to make the regenerative principle subservient to, or a useful adjunct, rather than an essential feature of their arrangements. Thus, the exhaust flue, which is frequently placed underneath their settings, instead of, as with us, upon the top, is to be found cased with an outer brick lining, between which and the flue the air supply to the furnace is drawn; and in this way much of the heat that would otherwise be lost by radiation is made use of in a simple and inexpensive manner. Some of the most successful of their furnaces will be found to bear a strong resemblance to the gas producer of M. Tessie du Motay, employed in America in the production of water gas, a description of which was given in *Engineering* of Dec. 12, 1879, and April 23, 1880. This, as will be recollected by those who have seen the description, is of a very simple construction, having, in lieu of grate bars, channels at bottom formed of fire-brick, from which is to be inferred the absence of any serious amount of clinkers. Others, again, have much wider openings, and are furnished with grate bars, after the manner of the Siemens furnace, both kinds being used either with or without an air or steam blast; and the object of all of them is to form a deep mass of incandescent fuel, so as to insure the decomposition of as large a proportion as possible of the carbonic acid generated by combustion.

It is perfectly evident that the employment of these furnaces, either wholly or only partially detached from the bench of retorts, must involve a very considerable loss of heat through radiation, and their economy notwithstanding would seem to be a serious reflection upon the solid fuel system. That they are economical, however, there appears to be little room for doubting. The last report of the German Continental Gas Association, for instance, makes prominent mention of the fact that it has been decided to adopt them throughout the whole of their works. At Cologne, where entirely new works have within the past five years been erected by the Municipality, under the guidance of their engineer, Herr Haganer, the whole of the retorts are heated by this method, the consumption of fuel being stated to be as low as 22 per cent. of the coke produced, with an economy of labor, owing to the facilities for firing and comparative absence of clinker, of no less than 40 per cent. These works, I may observe, will well repay a visit by any of the members of the Association who may be passing their holidays abroad, for they combine some of the best features both of English and Continental practice. When I called there about two summers ago, I was received with great kindness by Herr Haganer and his assistants, and the hour or two that I spent in their company tended in no small degree to dissipate any insular prejudices on the subject of gas making that, up to that time, I may have entertained. Throughout the works are to be found evidences of a thoughtful appreciation of the most advanced appliances, with a general arrangement very superior to what is ordinarily to be met with at home. It is scarcely necessary to inquire whether the question of gaseous versus solid fuel was considered in connection with any extension in this country contemporaneously with that at Cologne, but now that our attention has been fully aroused to the importance of it, it is not too much to expect that something decisive will be speedily achieved. Meanwhile the first fruits of real work will be made apparent to-day in the papers on the subject by Messrs. Frank Livesey and G. E. Stevenson, whose example it is to be hoped will find many imitators.

From the heating of the retorts to the disposal of the coal within them is a natural, if not in all respects an easy transition. High temperatures require to be followed up by well-ordered systems of charging and drawing. The sufficiency of hand labor, in point both of economy and of efficiency, has long been questioned; but it cannot be said that the principle of mechanical stoking has found by any means a ready and complete acceptance. Our attitude towards it hitherto may be described as one of cold neutrality. It is true, the desirability of employing machinery has been almost universally admitted; yet no sooner has the fertile brain of an inventor conceived a way by which this might be accomplished, than the onus of proof has been cast upon him, almost without reserve, or a helping hand. The effect of this has undoubtedly been to retard progress; nevertheless, sufficient has been established to justify our regarding the subject as one within the range of practical gas politics. In particular, the past year has been distinguished by the advent of a new aspirant for honors, in the person of our ex President, Mr. Warner, whose efforts and ingenuity we all hope may be crowned with success; while it has also been remarkable for the first competitive trial of distinct systems within the same works. Without entering into the respective merits of the various systems that are now offered for our acceptance, it may be observed generally that their success seems in a great measure to be proportioned, in the first place, to their departure from the ordinary method of treating the coal; and, in the next, to the observance of the conditions which experience has shown to be conducive to the best results in carbonizing. For example, in the earlier stages of its introduction, many fruitless attempts were made to improve the prospects of machinery by adapting the settings to its somewhat arbitrary requirements; whereas to-day we are witnesses of what may be called, without undue emphasis, a double triumph, in the combination of very simple machinery with a most admirable setting. Again, every endeavor to deal with the coal in the exact condition in which it is received into the works, or in which we have been accustomed to manipulate it, has resulted, more or less, in failure, for the sufficient reason, apparently, that the work of filling the scoop has seldom been attempted, and has never been satisfactorily accomplished. Now, however, this, the very pith and marrow of the difficulty, it is shown can be overcome by the simple expedient of breaking up the coal, so that it would seem as though we have only to satisfy ourselves that this may be done without injury to results, to ensure the removal of perhaps the only real obstacle in the way of the introduction of almost any form of mechanical appliances.

In the consideration of these important matters, the exercise of caution has been abundantly manifest; yet in another direction will be found evidences of mutability scarcely in harmony with its influence. It will appear that, in the opinion of the well-informed, we have, during a series of years, and upon slender grounds, been pursuing, with reference to condensation, a course of proceedure the very opposite of that which sound knowledge would dictate, or a regard for our own interests recommend, and that we are now invited to turn from the error of our ways, and retrace our steps. It is not so many years ago since the practice of conveying away the tar separately from the hydraulic main was general, not to say almost universal; but, in the course of time, and in obedience to a necessity that arose for the prevention of naphthaline deposits, this came to be reversed, in many instances the plan being resorted to of carrying the entire products of condensation, for a considerable distance, measured by temperature, along with the gas. This was so far successful, not only in the fulfilment of its original purpose, but also, according to many, in the improvement that was apparent in the illuminating power of the gas, that the speedy and general acceptance of the principle of the horizontal condenser followed almost as a matter of course. It is true the enrichment of the gas by its means rested, and may be said to still rest, upon evidence of a somewhat indeterminate character; nevertheless, there is the fact that the stated results have not in any instance been disproved. Whether the correct reason has been assigned for them is an entirely different matter. It is by no means either singular or impossible to be right in practice and yet wrong in theory. Success in the one is not incompatible with inaccuracy in the other. When, therefore, it is suggested, however faintly, that we should abandon that which experience has shown to be in some degree beneficial, for the reason, among others, that our theory is at fault, a little hesitation is not only excusable, but at the same time desirable also. It may be at once admitted that the opinion which has hitherto prevailed as to the beneficial effects of contact between gas and tar is, without qualification as to temperature, untenable. It was, in fact, discredited almost before it was conceived; and the more recent experiments of Mr. Young and others appear to have confirmed fully the earlier ones of the Rev. W. R. Bowditch, which first disclosed the almost opposite fact of the injurious effect of such contact except at certain high temperatures. How, then, are we to reconcile this with our practice? To me it seems that we have neither been altogether right nor altogether wrong. Our perception of the truth at the beginning has simply failed us towards the end of the process of condensation; but in our operations we have been shielded from much of the harm that might otherwise have resulted from this by the adaptability of the horizontal condenser for the purpose for which it is required. It is impossible, when speaking upon condensation, not to refer to the admirable series of articles, by Mr. R. H. Patterson, that appeared in the

Journal of Gas Lighting a few months ago. It is only scant justice to acknowledge the important service that has been rendered to gas manufacture by his clear and able elucidation of a somewhat abstruse and difficult subject. Mr. Patterson, it is needless to say, is agreed in condemning the principle of what may be called indiscriminate contact; but, what perhaps is equally interesting, he is by no means emphatic as to the efficiency of the means by which this is commonly sought to be promoted. He is, in fact, unable to discern any particular virtue in the horizontal condenser. On the contrary, it would seem to be the vertical form that possesses the best claims to be preferred. We are reminded by him of a circumstance that bears with some importance upon the determination of this question. Notwithstanding the great separation that takes place in the hydrulic main, there still remains with the gas, as everybody knows, throughout the whole of the subsequent process of condensation, and, in fact, until finally eliminated in the washers or scrubbers, a quantity of heavy tarry particles, that injure the gas by absorbing, or becoming dissolved by the light naphthas, and which it is consequently desirable should be got rid of as speedily as possible. Now, with regard to these, what is it reasonable to suppose takes place in the condensers? In the horizontal, on the one hand, the products of condensation may be expected to form a small stream along the bottom of each pipe, into which all tar, as it condenses, would naturally sink, and be covered over with the lighter oils and weak ammoniacal liquor. On the other hand, as pointed out by Mr. Patterson, the sides of a vertical pipe become coated, not alone with the lighter oils, but also with these objectionable tarry particles, which, in their course from the top to the bottom, present a continually changing surface to the gas, with a result that may be imagined. On this supposition the efficiency of the horizontal condenser not only does not depend upon the presence of the products of condensation throughout its entire length, but would really be increased by their removal as the temperature becomes diminished. As ordinarily employed, its effect may be described as beneficial at the higher temperatures (say 80° or 90°), in so far as it permits of contact with the light naphthas, undisturbed, so to speak, by the presence of the heavy tar; and servicable at the lower temperatures, in so far as it may be the means of avoiding contact with the products of condensation.

The proposals, however, that are now made to us possess a wider significance than can attach to the somewhat vexed question of what is the best form of condenser. Whatever system be preferred, there inevitably remains with the tar much that would enhance the illuminating power of the gas, if only it could be practically applied to the purpose. This it is now proposed to do, either by the maintainance of a temperature, at or near the hydraulic main, sufficiently high to prevent the union of the light naphthas with the tar, or by re-heating the latter, so as to restore the naphtha to the gas. The advantage thus to be derived can of course be determined accurately only by experience. Against the permanent gain in illuminating power would have to be set the first cost of plant and of carrying out the process, besides the lessened value of the tar consequent upon the abstraction of some of its most valuable constituents; but that the financial results are not unsatisfactory may be inferred from the increasing favor with which the various apparatuses now under consideration have come to be regarded. In the St. John Carburetter and Purifier, as it is called, the invention of an American engineer, and which has been employed, not alone in America, but also in this country for several months past by Mr. T. O. Paterson, at the works of the Rochdale Corporation, we seem to be furnished with a direct proof of the actually beneficial effect of contact between the tar and gas at a temperature considerably below that of the outlet of the hydraulic main, while in the case of Messrs. Aitken and Young's Analyzer the application of extraneous heat is said to be productive of a yet more complete economy. It is also to be inferred, from no mention being made of it, that the difficulty to be apprehended from having to deal with the air in a much more viscid state than is usual, either has not arisen or has been overcome; so that, the question being before us in a fairly practical shape, it may be desirable to consider how far, at any rate, the essence of the proposition may be imported into our ordinary practice.

We learn, in the first place that the heat which is usual in the hydraulic main, although, so far as it can be made use of, beneficial, is insufficient to maintain the complete separation of the lighter oils. Next, that the heat determined upon as adequate for such maintenance should be kept up, as nearly as possible, for a period long enough to admit of the deposition of all heavy tarry matter. Thirdly, that all liquid products should be drawn off before the temperature has been sensibly reduced. Lastly, that means should be taken to eliminate, while the temperature is still moderately high, those tarry particles that otherwise would be carried forward with and do injury to the gas. These conditions observed, the subsequent process of cooling will probably be a matter of comparative unimportance, care being taken not to pursue it too far. Whether they are such as can be only practically applied is a question that can only be decided by experiment. Mr. Patterson has suggested that the temperature in the hydraulic main might be raised to the required point, say about 190°, by the aid of steam; and he would avoid the formation of pitch, if this were to be apprehended, by employing a shallow, or the Livesey hydraulic. It is to be feared that he would find his preventive of no avail. Shallow hydraulics—at least so far as I have had experience of them—however useful they may be in preventing the accumulation of certain forms of carbonaceous matter, are powerless against a sufficiently high temperature for the formation of pitch, for they only choke up the sooner for being shallow. This, however, by the way. There is little reason for supposing that a moderate increase of temperature could not be maintained without inconvenience, but the necessity for any extraneous assistance may well be doubted. It ought not to be difficult to render available for this purpose the enormous reserve of heat within the retort bench below, by regulating the amount of radiating surface between the mouthpiece and the hydraulic main; or, in other words, by adapting the retort fittings to our requirements. Another way would be by raising the heat of the retorts themselves, by which plan a double advantage would be secured. By either method, or by a combination of the two, it should be possible to attain to the desired temperature in a way at once simple, direct, and practicable; and this, coupled with a system of condensing pipes, inclining toward the hydraulic main yet leading from it, would apparently secure much, although perhaps not all of the advantages of supplementary appliances. It will at all events appear probably, upon careful consideration, that the practical limits of the application of what it may not be incorrect to describe as the strictly scientific method are within the reach of simple and admissible modifications of existing means.

In return for the permissive rights, neither excessive nor extensive, without which the business of gas undertaking could not be carried on, many restrictions have been imposed upon gas companies. It is hardly to be supposed, however, that these have been deliberately intended as fetters upon their industry, but that some have operated as such there is little room for doubting. In a significant article upon coal gas illumination the *Times* newspaper has recently remarked upon the comparative apathy shown by English gas makers with regard to the employment of gas by the consumers. We may go further, and admit that there is little indeed to be found, on the part of our leading gas companies, of recognition of the principle of community of interests between manufacturer and consumer such as so freely obtains in the enlightened administration, say, of the Paris Gas Company. It should be inquired why it is that in this country the consumer meets with so little encouragement in his desire to avail himself of the convenience and economy of gas, the answer will be that the law has set bounds to the operations of the companies which they cannot pass; the sanction of the Imperial Parliament—of Queen, Lords, and Commons—being necessary to render legal the sale or manufacture by them of even a single cooking stove. It will be naturally and correctly inferred that, inasmuch as such sanction would cost both effort and money to obtain, success being at the same time by no means assured, and dividends tolerably secure without it, there is little inducement for enterprise in this direction. The *Times* has said truly that "they manage these things better in France," for in the arrangements that are in force in the sister capital for promoting the intelligent use not only of gas, but of gas products, it is impossible not to recognize the beneficial results of a policy having for its object the control of these industrial monopolies for the mutual benefit of all concerned. It is true, there has occurred a period when the perceptions of our rulers may be said to have temporarily awakened to the desirability of establishing improved relations between the companies and the public, resulting in the adoption of the sliding scale. It is true, likewise, that the description I have given is by no means susceptible of general application. During the last few years a great change has taken place. In some few instances, under the authority of Parliament, in more numerous instances without such authority, or with authority ill defined, much is now being done for the spred of information among the consumers; and in the many exhibitions of gas heating and lighting apparatus that continue to be held in all parts of the kingdom, are to be recognized the gradual breaking down of a barrier created by jealousy on the one side, and by indifference on the other, and the re-uniting of interests that ought never to have been considered apart. May we not venture to hope that the liberality of the new Parliament will be exercised in acknowledging the efforts that are thus being made, and in cementing this most auspicious union by the passing of a general act in the shape, it may be, of a further amendment to the Gas Works Clauses Act, empowering all gas companies and corporations posessing gas undertakings not to manufacture, for this is neither necessary nor altogether desirable, but to sell or hire to their consumers, under reasonable limitations, any apparatus that it may be found convenient or economical to employ in connection with the consumption of gas. By adopting this course much unnecessary expense in the procuring of special acts would be avoided; the position of gas manufactures with regard to the subject would be clearly defined; while it could not but be acceptable to the makers of the apparat-

uses in question, from the prospect that would be held out to them of a widely extended market for their wares.

It is not, however, to be denied that very much may be done without any direct legislative enactment. The gas maker who waits to be made good, if I may be allowed the expression, by act of Parliament, is in much the same position as the wagoner in the fable appealing to Hercules. There has never, in reality, been anything to hinder him from endeavoring to instruct his consumers in the economical uses of gas, nor from bringing under their notice the most modern and approved appliances, supposing him to have been so minded; nor are there at the present time any obstacles in the way of the fulfillment of this obligation, if such it may be termed. The way has been ever open to him to effect, by precept and by example, very much of the good that is expected to be achieved by projects of a more or less ambitious character; but the consequence, primarily, perhaps, of legislative restrictions, but mainly of the tacit acceptance by the companies of the position assigned to them, that of gas makers pure and simple, has been to divorce the science of the application of gas from that of its manufacture. The loss to the consumer from this unnatural separation has been, without exaggeration, enormous. In the matter of light alone, it is almost a trite observation that very many have continued for years to pay 20, 30, and even as much as 50 per cent. more than they need have done had they been under the guidance of sound advice in the choice of burners.

How useful to them would be a permanent exhibition of apparatus, after the model of those in Paris, or the services of a skilled official attached to each sufficiently large undertaking, specially qualified to advise them on all matters relating to the uses of gas; and what a valuable acquisition might not such a one prove to his employers, although not deriving his authority from any act of Parliament.

Perhaps the most successful example on record of the direct application of heat as a mode of motion is furnished by the modern gas engine. The recent development of this, after a succession of efforts, is one of the achievements of our time, and bids fair to secure for it a high place in the industrial annals of the century. Its progress has been watched with lively interest from two opposite standpoints. On the one side, gas makers have noted with satisfaction the promise of an additional source of future increase; while, on the other, the electrician has almost brought himself to regard it as a means through which the supremacy of coal gas as an illuminant may be vigorously disputed. It would be strange if the weapons furnished by ourselves should ever come to be effectually employed against us; yet this, in the opinion of some, is not beyond the limits of probability. In the minutes of evidence taken last year before the Select Committee of the House of Commons on Electric Lighting will be found abundant testimony in favor of the economy of the gas engine, while at the same time the economy of the manufacture of the gas itself is sought to be discredited; so much so that, on reading them, one is almost tempted to imagine that henceforth the continuance of its manufacture is to be justified only for such purposes as that of furnishing motive power for the "light of the future;" or, at any rate, that this is to be its position when the electric light shall have been perfected and established. Even upon this supposition, however, consolation is left to us in the reflection that we shall remain the purveyors of a fuel which, in point of cheapness and convenience, it ought to be difficult, if not impossible, to surpass; and which, if ever the occasion should arise, might enable us to supply, without fear of competition, even the electric light itself. But there is little necessity for indulging in speculation of this kind. The time is obviously far distant, if it ever is to come, when coal gas shall be valued less for the light than the heat it affords. What chiefly concerns us in such a probability, remote though it be, is the refutation it furnishes of the plea so influentially urged against gas manufacture, that it is, comparatively speaking, an uneconomical science. It is scarcely to the purpose to be told that coal converted into electric energy can be made to produce more light than it is possible to obtain from an equal weight when subjected to destructive distillation. It would be absolutety condemnatory of electric lighting if this were not so, seeing that in the one process the entire quantity of coal is reproduced, or is represented in the form of light; whereas, in the other, only a fractional part is converted into illuminating matter. This, however, does not of itself settle the question of comparative economy the ultimate determination of which is influenced by a variety of considerations which it is unnecessary to discuss. It is somewhat more to the point to urge, as a reason why gas should be employed for the production of light, indirectly through its conversion into electric energy, rather than directly by means of the ordinary gas burner, that only in this way can be utilized to its fullest extent the heat generated by combustion; but here, again, practical considerations prevail, and so long as it is found desirable to retain the present system of gas lighting, so long also may it be expected that the unavoidable expenditure of heat by which it is attended will be endured, even if it be not rendered more and more subservient to general requirements. Meanwhile we may wait with perfect equanimity the coming to the front this question of heat or light, because already the economy of gas manufacture for the sake of heat alone has been amply vindicated. In the gas engine we have means by which the gaseous products alone are able to exert an effect equal to that of the entire weight of the coal required for its production when expended upon an ordinarily well-constructed high pressure non-condensing steam engine. That is to say, taking 18 feet of gas to be the consumption per indicated horse power per hour of the gas engine, which is a little in excess of what is found to be required of the largest of them, and four lbs. of coal as the consumption of the steam engine, the one would nearly enough represent the gaseous products of the other, while the actual weight of material consumed by the two engines would be in the proportion of one to six. Doubtless, a much smaller consumption with the steam engine than four pounds per horse power is readily attainable; yet the greatest economy that has ever been secured by the aid of elaborate and costly contrivances still leaves the proportion, weight for weight, as about one to three in favor of the infant gas engine—this child of such great promise.

It is, of course, open to remark that the 18 feet of gas cost more than the two pounds, or even the four pounds of coal; and so they do to the consumer, who willingly pays, in the shape of profit to the manufacturer, for the advantages he enjoys in the use of the gas engine; but for our own requirements its superiority in all respects would seem to be beyond question, having regard to the almost nominal cost of gas in most cases. We do well to bear in mind also that, in according to it such a practical recognition, we are helping forward an agency that may be destined to exercise a powerful influence upon the fortunes of our industry.

Just now I hinted at the possibility of bringing more under control the heat generated during combustion when the gas is used for illuminating gurposes. This heat, although a source of comfort rather than otherwise to the majority of consumers, stands very much in the way of the extended use of gas in confined spaces, and in houses of the better class, where also, it is needless to say, the products of combustion constitute a real objection. No doubt the proper remedy for this is efficient ventilation; but unfortunately the practice of this most necessary art is "more honored in the breach than in the observance." Left to our own resources, however, the difficulty is not by any means a formidable one. What is known as the "Benham" system has long been applicable to the majority of cases, and Mr. Sugg has recently introduced what may be recognized as a modification of this, for use in connection with his large Argands. These latter have also rendered especially practicable the employment of a simple form of chandelier furnished with a central tube, by which the entire products of combustion may be carried off, and either disposed of in the nearest flue, after the manner of the "Benham" system, or they may be made use of for heating an upper room by means of a radiating stove or a simple coil of piping. There is probably nothing particularly novel in such an arrangement, but it satisfies, at a moderate cost, the conditions considered necessary to comfort by a numerous and influential class of gas consumers, while at the same time it opens up a way for the utilization of heat that would otherwise be worse than wasted.

Heating by gas having come to be regarded with increasing favor, improved appliances follow almost as a matter of course, although much remains to be done. Gas fires, for instance are still for the most part but indifferent imitations of a cheerful coal fire, except in their inevitable waste by way of the chimney; and yet their use is rapidly extending. It may be inferred from this that their employment would become much more general if the resemblance could be rendered more complete; or, better still perhaps, that the heating agency of gas might speedily enjoy a fuller recognition, if the tastes of the public would admit of our dispensing altogether with the art of imitation, and relying solely upon the intrinsic merits of the fuel that we have to offer. The waste, even in the most approved forms of gas fires, cannot amount to less than from 20 to 25 per cent., and ought to furnish a strong argument in favor of the substitution of stoves by means of which the whole of the heat generated might be applied to the purpose for which it is required. It is satisfactory to note that advances are being made in this direction, and amongst others of recent introduction may be mentioned the "Adams" and the "Ritchie" stoves, as, although proceeding on different lines, complying in a high degree with the conditions essential to the combination of economy with efficiency.

Although so much is being done for these subsidiary uses of gas, it is not to be supposed that the original, and what in all probability will, for a long time to come, be the main purpose of its manufacture, has in any degree been overlooked. Improved burners furnish one of the most satisfactory evidences of recent progress. The principle of controlling pressure at the point of ignition, as a means of obtaining higher and uniform results, is becoming widely acknowledged in the many excellent combinations of regulator and burner by which, without additional cost for the gas, increased comfort may be dispensed to every household; while the prospect of rivalry has stimulated into being, for outdoor purposes mainly, burners of large power, that have fully sustained the superiority of coal gas over the electric light.

To Mr. Bray our thanks are due for his development of the flat-flame burner into a lighting medium of a very high order, and for his vindication of its claims to practical consideration; although with Mr. Sugg remains the honor of being the most successful expositor of the illuminating power of coal gas.

I have had occasion to refer to the theoretical disproportion between the heat of burning gas and the light evolved. Whether this heat may be regarded as the measure of the light that will ultimately be obtained, it is perhaps impossible to say; but certain it is that the limits of progress in this direction have not yet been reached.

Every successive investigation reveals the possibility of further improvements, and the enlargement of the Argand by Mr. Sugg has furnished a development of light unequalled by any other form of burner. Some of the latest results show an improvement of fully 15 per cent. over anything previously attained, and upwards of 30 per cent. in advance of the Referees standard burner.

It is not necessary to dwell upon the significance of this discovery. It may be tendered as one answer out of many to those who would assign to gas lighting, in the immediate future, a secondary position, as a science outstripped in the march of progress; it may be accepted by ourselves as an assurance, if such were needed, of the rich reward that continues to await the patient and intelligent investigator.

[From the "Journal of Artificial Light."]

Electricity and Paraffin as Competitors With Gas.

Last week we made some mention of Mr. Hunt's reference to the question of electric lighting, and as the topic is not one lightly to be thrown aside, we may be excused for recurring to the subject.

The history of electric lighting is not one of yesterday. It has engaged the time and attention of scientific men of eminence in various departments for nearly half a century; but it is only some two years ago since it bulked so prominently in the public eye. We question very much if there would have been the slightest signs of agitation but for the efforts of Yankee speculators, who were not slow to perceive that if they could persuade people that electric lighting was *un fait accompli*, they might realize a fortune in a comparatively brief space. How well they succeeded in their object the events of the past eighteen months abundantly prove.

All along, even when the apparatus for producing the electric light was yet crude and altogether unequal to the work it was called upon to perform, we prophesied its failure, and now that it has been perfected as far as human ingenuity can devise, we are not inclined to alter our opinion. No doubt the finger of the enthusiastic electrician will be pointed to the Thames Embankment, to certain of the streets of Paris, and to the Salon in that gay city, as evidence of the success of the system, but still our views remain unchanged. We have over and over again stated that if a large space requires to be lighted as bright as day, or if the public are willing to endure any amount of taxation in order that they may be in a position to recognize a friend half a mile away, or read their papers on the public street, they have the means of doing so by introducing the electric light; but if the end in view is merely to improve street lighting as it now exists, and has existed almost from the time when the old oil lamp was abolished, the gas mains which intersect every street in our cities and towns are amply sufficient to supply the material, and Mr. Sugg and Messrs. Bray will advise corporations and companies as to the most approved burners which ought to be used.

It is all very well to say that with electricity we are able to concentrate the light of ever so many thousand candles upon one particular spot, and that, taking that immense light, and comparing it with the cost of gas to produce a similar illumination, electricity is the cheaper of the two. This may not be the case. We are quite indifferent as to the results of the comparison. The point which we have to examine, and the point which is of primary importance to gas manufacturers, is whether by any known process of subdividing the electric light it can be brought into competion with gas. We have heard a great deal from the other side of the Atlantic on this aspect of the question, and we have even read articles published in journals this country, which ought to have known better, to the effect that this end had been achieved. We have waited long for the practical outcome of these statements, and from all that we can learn we will require to wait for a still longer period if we desire to see the accomplishment of all that has been predicted for the electric light.

It is not upon the utilization of large lights that gas companies must alone depend for success; it is upon the mighty army of individual consumers; and so long as the subdivision of the electric light remains an unsolved problem, so long will gas retain its superiority.

If gas companies have any foe in the field at all, it comes rather from the products of shale distillation than from electric generators. On this point Mr. Hunt expressed a strong opinion, and the word of warning which he gave to gas companies not to be too autocratic in their action should not be lost sight of. Gas, like every other commodity, is an article in the market for sale, and although it may be that special powers have been obtained to authorize its manufacture in any special district, it does not follow that special powers have been given to force the inhabitants in that district to purchase the manufactured article. If a company—and we would always draw a definite line between a company and a corporation—are inclined to adopt a high-handed policy, they should be reminded that if electricity cannot enter into competition with them, the paraffin oil lamp can. The extent to which paraffin is used, even in large cities where gas is plentiful and cheap, is something astounding, and although it may not be either quite so clean or so convenient, yet a consumer will rather put up with the little additional dirt and trouble than submit to what he considers an injury. By the adoption, therefore, of a considerate policy, companies may largely increase the number of their consumers. So far we have been speaking more particularly with reference to lighting. Within recent months, however, a wide and extensive field has been opened up, and if companies only show wisdom in taking the proper course, there is no reason why the manufacture of gas should not be doubled—why the make and the demand for gas should not be as great during the hours of light as during the hours of darkness. For heating and cooking purposes gas has been proved to be as economical and certainly far more cleanly than coal fires; and if gas companies were to make gas consumers thoroughly understand this, and if they were to rent out stoves as they rent out meters, it would not take long to convince consumers of the economy and the utility of the new system. There can be no doubt that the enterprising gas maker will be the most successful in the end, and we look forward with confidence to the time when gas companies, by introducing the best mechanical apparatus for the consumption of gas, whether for lighting, heating or cooking, will reap a more abundant harvest than they have done in the past. The hints given by Mr. Hunt in this condition will command the attention and respect of a wide constituency.—

[From the "Chemical News."]

On a Fourth State of Matter.

IN A LETTER TO THE SECRETARY OF THE ROYAL SOCIETY.

By W. Crookes, F.R.S.

7 Kensington Park Garden,
London, W., April 29, 1880.

Dear Professor Stokes:—

In introducing the discussion on Mr. Spottiswoode and Mr. Moulton's paper on the "Sensitive State of Vacuum Discharges," at the meeting of the Royal Society on April 15, Dr. de la Rue, who occupid the Chair, good-naturedly challenged me to substantiate my statement that there is such a thing as a fourth or ultra-gaseous state of mater.

I had no time then to enter fully into the subject; nor was I prepared, on the spur of the moment, to marshall all the facts and reasons which have led me to the conclusion. But as I find that many other scientific men besides Dr. de la Rue are in doubt as to whether matter has been shown to exist in a state beyond that of gas, I will now endeavor to substantiate my position.

I will commence by explaining what seems to me to be the constitution of matter in the three states of solid, liquid, and gas.

1. First as to solids:—These are composed of discontinuous molecules, separated from each other by a space which is relatively large—possibly enormous—in comparison with the diameter of the central nucleus we call *molecule*. These molecules, themselves built up of *atoms*, are governed by certain forces. Two of these forces I will here refer to—attraction and motion. Attraction appears to be independent of absolute temperature; it increases as the distance between the molecules diminishes; and were there no other counteracting force the result would be a mass of molecules in actual contact, with no molecular movement whatever—a state of things beyond our conception—a state, too, which would probably result in the creation of something that, according to our present views, would not be *matter*.

The force of cohesion is counterbalanced by the movements of individual molecules themselves, movements varying directly with the temperature, increasing and diminishing in amplitude as the temperature rises and falls.

The molecules in solids do not travel from one part to another, but possess adhesion and retain fixity of position about their centres of oscillation. Matter, as we know it, has so high an absolute temperature that the movements of the molecules are large in comparison with their diameter, for the mass must be able to bear a reduction of temperature of nearly 300° C. before the amplitude of the molecular excursions would vanish.

The state of solidity therefore—the state which we are in the habit of con-

sidering *par excellence* as that of *matter*—is merely the effect on our senses of the motion of the discrete molecules among themselves.

Solids exist of all consistences, from the hardest metal, the most elastic crystal, down to thinnest jelly. A perfect solid would have no viscosity, *i.e.*, when rendered discontinuous or divided by the forcible passage of a harder solid, it would not close up behind and again become continuous.

In solid bodies the cohesion varies according to some unknown factor, which we call chemical constitution; hence each kind of solid matter requires raising to a different temperature before the oscillating molecules lose their fixed position with reference to one another. At this point varying in different bodies through a very wide range of temperature, the solid becomes liquid.

2. In liquids the force of cohesion is very much reduced, and the adhesion or the fixity of position of the centres of oscillation of the molecules is destroyed. When artificially heated, the inter-molecular movements increase in proportion as the temperature rises, until at last cohesion is broken down, and the molecules fly off into space with enormous velocities.

Liquids possess the property of viscosity—that is to say, they offer a certain opposition to the passage of solid bodies; at the same time they cannot permanently resist such opposition, however slight, if continuously applied. Liquids vary in consistency from the hard, brittle, apparently solid pitch to the lightest and most ethereal liquid capable of existing at any particular temperature.

The state of liquidity, therefore, is due to inter-molecular motions of a larger and more tumultous character than those which characterise the solid state.

3. In gases the molecules fly about in every conceivable direction, with constant collisions and enormous and constantly varying velocities, and their mean free path is sufficiently great to release them from the force of their adhesion. Being free to move, the molecules exert pressure in all directions, and were it not for gravitation they would fly off into space. The gaseous state remains so long as the collisions continue to be almost infinite in number, and of inconceivable irregularity. The state of gaseity, therefore, is pre-eminently a state dependent on collisions. A given space contains millions of millions of molecules in rapid movement in all directions, each molecule having millions of encounters in a second. In such a case, the length of the mean free path of the molecules is exceedingly small compared with the dimensions of the containing vessel, and the properties which constitute the ordinary gaseous state of matter, which depend upon constant collisions, are observed.

What, then, are these molecules? Take a single lone molecule in space. Is it solid, liquid, or gas? Solid it cannot be, because the idea of solidity involves certain properties which are absent in the isolated molecule. In fact, an isolated molecule is an inconceivable entity, whether we try, like Newton, to visualise it as a little hard spherical body, or with Boscovich and Faraday, to regard it as a centre of force, or accept Sir William Thomson's vortex atom. But if the individual molecule is not solid, *a fortiori* it cannot be regarded as a liquid or gas, for these states are even more due to inter-molecular collisions than is the solid state. The individual molecules, therefore, must be classed by themselves in a distinct state or category.

The same reasoning applies to two or to any number of continuous molecules. provided their motion is arrested or controlled, so that no collisions occur between them; and even supposing this aggregation of isolated non-colliding molecules to be bodily transferred from one part of space to another, that kind of movement would not thereby cause this molecular collocation to assume the properties of gas; a molecular wind may still be supposed to consist of isolated molecules, in the same way as the discharge from a mitrailleuse consists of isolated bullets.

Matter in the fourth state is the ultimate result of gaseous expansion. By great rarefaction the free path of the molecules is made so long that the hits in a given time may be disregarded in comparison to the misses, in which case the average molecule is allowed to obey its own motions or laws without interference; and if the mean free path is comparable to the dimensions of the containing vessel, the properties which constitute gaseity are reduced to a minimum and the matter then becomes exalted to an ultra-gaseous state.

But the same condition of things will be produced if by any means we can take a portion of gas, and by some extraneous force infuse order into the apparently disorderly jostling of the molecules in every direction, by coercing them into a methodical rectilinear movement. This I have shown to be the case in the phenomena which cause the movements of the radiometer, and I have rendered such motion visible in my later researches on the negative discharge in vacuum tubes. In one case the heated lamp black and in the other the electrically excited negative pole supplies the *force majeure* which entirely or partially changes into a rectilinear motion the irregular vibration in all directions; and according to the extent to which this onward movement has replaced the irregular movements which constitute the essence of the gaseous condition, to that extent do I consider that the molecules have assumed the condition of radiant matter.

Between the third and fourth states there is no sharp line of demarcation, any more than there is between the solid and liquid states, or the liquid and gaseous states; they each merge insensibly one into the other. In the fourth state properties of matter which exist even in the third state are shown *directly*, whereas in the state of gas they are only shown *indirectly*, by viscosity and so forth.

The ordinary laws of gases are a simplification of the effects arising from the properties of matter in the fourth state; such a simplification is only permissible when the mean length of path is small compared with the dimensions of the vessel. For simplicity's sake we make abstraction of the individual molecules, and feign to our imagination *continuous* matter of which the fundamental properties—such as pressure varying as the density, and so forth—are ascertained by experiment. A gas is nothing more than an assemblage of molecules contemplated from a simplified point of view. When we deal with phenomena in which we are obliged to contemplate the molecules individually, we must not speak of the assemblage as *gas*.

These considerations lead to another and curious speculation. The molecule—intangible, invisible, and hard to be conceived—is the only true *matter*, and that which we call matter is nothing more than the effect upon our senses of the movements of molecules, or, as John Stuart Mill expresses it, "a permanent possibility of sensation." The space covered by the motion of molecules has no more right to be called matter than the air traversed by a rifle bullet can be called lead. From this point of view, then, matter is but a mode of motion; at the absolute zero of temperature the inter-molecular movement would stop, and although *something* retaining the properties of inertia and weight would remain, *matter*, as we know it, would cease to exist.

Believe me,
Dear Professor STOKES,
Very sincerely yours,
WILLIAM CROOKES.

[From "Journal of Artificial Light."]

Danger to Health from Gas Escapes.

In the Court of Common Pleas, before Lord Coleridge and a jury, a fishmonger, named Johnston, sued the Gas Light and Coke Company for damages.

There were originally two actions brought by two families living under the same roof in Ellesmere Road, Old Ford, for injuries to their health, arising out of an escape of gas from a main belonging to the defendants. In the course of the case all claim for damages by one of the families was practically abandoned, it being demonstrated that no real injury had been sustained; but in the case of the other family, who lived on the ground floor of the house, the claim was persevered in, one of the plaintiffs in particular, the father of the family, rating the consequences to his health somewhat highly. According to his account, he was a fish salesman at Billinsgate, and at the time of the accident—December, 1878—he was making a profit out of his business of £10 a week. The escape of gas into the house took place in the night, and early in the morning he was found insensible. For five weeks he was unable to go near Billingsgate, and it was three months before he was fit to do any business. Even now he had not recovered. The consequences in a pecuniary way were disastrous. His customers had left him, and his profits were reduced by a third. He had been obliged, moreover, to incur considerable expense in changing his house, and there were medical expenses besides for himself and his family. Two doctors were called to confirm his story, one of whom had paid him seventy visits within the three months; and both agreed that the plaintiff's symptoms were attributable to gas poisoning. In cross-examination the plaintiff admitted that the doctors had not been paid, and that he kept no books or vouchers of any kind, nor had he any banking account. It was, he said, a ready money business. With respect to the alleged negligence, on which this claim for damages was founded, the plaintiff's case was that previous to his tenancy of the house it had been served with gas by a service pipe connected with the main, which had been subsequently stopped, and that the escape was probably due to this stopping or plugging having been insufficiently executed. Evidence was called also to show that when the main was inspected after the escape there was a fracture discovered, and that the pipe itself had deteriorated from the effects of sulphur and ammonia, with which the adjacent soil was saturated; and, lastly, one witness was called who deposed that a week before the accident he had called at the company's office, and given distinct notice to them that gas was escaping.

The case for the defendants, in reply to this, consisted, first, of an explicit denial that any complaint had been made at their office, and with respect to the fracture of the pipe and the escape of the gas, in a full admission of both facts, but with a positive denial of their responsibility for the conse-

quences. The pipes in question had been laid down in 1864, and were not only of the best obtainable quality, but had been laid down in a most admirable manner. The particular fractures which had taken place was attributed to the fact that in 1866, when the houses in the street were built, certain sewage-pipes crossing the road had been laid down, and that in executing the work the earth in which the gas main lay was not only disturbed, but was replaced, not by earth, but by rubbish, with the natural consequence that the pipe sank and ultimately broke. Several scientific witnesses of repute, as well as officials of the company, were called to prove these facts, as well as to show that the pipes after they had been laid down had been most carefully tested; and the result of their opinion was not only that the fracture was due to the subsidence of the soil, but that even if the excavation for the drains had been brought to the notice of the company, which, in point of fact, it had not, it would not have been possible for them to have made the earth around the main as compact as it was at first; or, in other words, that they could not have prevented the subsidence. The case for the defendants with respect to damages was no less overwhelming. Dr. Hastings and Dr. Tidy were called, and gave it as their opinion that it was impossible that a man could have suffered as the plaintiff had described from the effect of poisoning by coal gas. He had admitted in cross-examination that he had gone to the public house the same day, and had consulted a solicitor the day after, and this bore out their opinion that the effect of the gas was merely transitory. Coal gas, if taken in sufficient quantities, would kill; but once expelled from the lungs, no lingering consequences remained, and the longest case on record of coal gas poisoning showed that the patient recovered within a week.

Lord Coleridge, in summing up, commented upon two actions having been brought, which was probably to be explained by the one word "costs," the defendants being a powerful company. He had been trying causes throughout the week, and most of them were utterly unworthy of the attention of a Middlesex special jury. They had taken up a most disproportionate time, and the damages claimed must have been swallowed up ten times by the costs. With reference to the case before them, the jury must say whether the defendants had done or had omitted to do that which a reasonable man would or would not do under the circumstances. They would not be liable if the escape of the gas was beyond their control. It had been said that they should from time to time have inspected the pipes and the soil, but it must be remembered that the defendants were responsible for 1500 miles of pipes, and it would be adding a new terror to a London residence if the streets were to be taken up for the purpose of making subterranean excursions with a view to ascertain whether there had been any subsidence of the soil. It would be a different thing if the company had received notice of an escape and had disregarded it, but the evidence of notice in this case had been contradicted, and the jury must judge of the value to be given to it. With respect to the damages, it seemed impossible not to think there had been exaggeration on the part of the plaintiff, but this matter was also entirely for the jury, and supposing they found negligence, they must say what damages the plaintiff deserved.

The jury almost immediately found a verdict for the defendants.

Mr. Willoughby, Mr. Simms, and Mr. Whittaker were for the plaintiff; the Attorney-General, Mr. Morgan Howard, Q.C., and Mr. Tyrrell Paine were for the defendants.

The Cause and Prevention of Oil Fires.

The prevalence of oil tank fires this year and the great loss that has resulted from them, have led to more careful investigations into their causes, and to inquiry as to the means of prevention. Most of these fires are caused by lightning. If the fire was confined to the tank struck, little damage would result, but, unfortunately, that is seldom the case. The burning oil boils over or the tank explodes, and the oil pours out in streams of fire, igniting other tanks and houses that are in its course, and, as the buildings in the oil regions are mostly of wood, the loss is usually heavy and widespread.

Some four years since, in an editorial on these tank fires, we gave a theory as to the cause of the attraction they seemed to have for lightning, to the effect that from every oil tank that is struck by lightning there is a constant escape of light hydrocarbon vapor, which forms a permanent cloud or column, rising to a great height above the tanks. This vapor is a conductor, which the lightning naturally follows, and which attracts it. We see that the *Scientific American* has adopted this theory and indorses it, but fails to make plain one point—that this column of vapor rises only from tanks with wooden tops; or, in other words, an iron-top oil tank is never struck by lightning.

This is a remarkable fact, and points out the remedy against the origin of these fires. We have carefully watched them, and speak from positive knowledge of all tank fires that have been caused by lightning during the past seven years, except the one at Titusville early this month, and we state with confidence that an iron-top tank has never been struck by lightning. Of the Titusville fire we have no positive knowledge on this point, but, judging from the locality and the size of the tank struck, we should say that it was a wooden-top tank.

There is also one case, we believe, in which an iron-top tank was fired by lightning, but in this case the lightning struck a pipe leading to the tank at a point some distance from it. In a word, the remedy for these oil fires caused by lightning seems to be the changing to iron of all wooden-top tanks.—*Iron Age.*

Proceedings of the Third Annual Meeting of the Western Gas Association.

[Owing to unavoidable causes the continuation of the publication of the proceedings of the above-named Association is deferred until the next issue, the report having failed to reach us.—Ed.]

Petroleum and Coal Benzine.

The fact that naphtha, benzine and benzole are not defined with sufficient clearness was brought under notice by the labors of the Berlin commission for the classification of merchandise. In consequence of the protectionist law of July 15, 1879, mineral oils fit for lighting purposes were made subject to a duty of ten marks per 100 kilos, whilst tar oils and mineral oils not fit for lighting are still admitted duty free.

According to Dr. Hausserman only a very small quantity of American petroleum arrives in Europe in its crude, unpurified state. The greater part has been treated with concentrated sulphuric acid and submitted to fractional distillation.

It is thus, in the first place, resolved into three products, *i.e.*, naphtha, refined petroleum, and petroleum dregs. The naphtha, which forms from five to ten per cent. of the crude petroleum, is a clear, colorless, mobile liquid, which boils at from 122° to 302° F., and varies in specific gravity from 0.65 to 0.72. It is often sold under the names of ligroin or spirit, and is applied to a variety of purposes. In Europe it is again treated to sulphuric acid and subjected to fractional distillation, being thus divided into four parts. The portion which passes over first, at from 104° to 158°F., is known as petroleum ether, and has the specific gravity of 0.64 to 0.66. It serves for the extraction and solution of fatty matters, etc. The second fraction distilling from 149° to 194°F., is gasoline, known also as neoline, rhigoline, canadol, etc. Its specific gravity is 0.67, and it serves for the gasoline gas process. The third fraction, which goes over between 194° and 230°F., is petroleum benzine, which is used as a solvent and for removing spots. Its specific gravity is 0.69 to 0.71. The residue in the still is used as a substitute for oil of turpentine. Its specific gravity is 0.75, and it begins to boil at 248°F.

The second product obtained in distilling crude petroleum is the ordinary refined petroleum or kerosene used as a lamp oil. Its specific gravity is 0.82.—*Stowell's Petroleum Reporter.*

The Coal Trade of the World.

* * * * *

And, lastly, we come to the coal resources of countries other than Great Britain and the United States. The output of France in 1878 was 17,096,500 metric tons of 2204 lbs. each, or 36 lbs. less than the English ton. What is called anthracite is found in the departments of the Nord, Sarthe, Mayenne, Isere and Calvados, and the output is 1¼ million tons. Lignite is found in Isere, Haute-Saone, Vaucluse, and Bouches-du-Rhone. In the other basins coal only is mined. Something like 2,000,000 tons are made into coke annually. Large amounts of artificial fuel are made annually from the slack or debris. In the Valais, Switzerland, is found anthracite coal with the following component parts by analysis—

Carbon, 88.16; hydrogen, 2.15; oxygen and nitrogen, 1.34; ash, 8.35. The quantity of coal used in the country is 500,000 tons annually, and it is all imported. The use of American anthracite in Europe has attracted attention to the Valais coal, and no doubt the local supply will be developed. The coal area of Belgium is stated at 510 square miles, and the production averages 15,000,000 tons per annum. But little true coal is mined in Italy, although there is said to be good coal and anthracite in the province of Udine. Of the lignite there are 125,000 tons raised annually, and 95,000 tons of peat. Great Britian sends 1,500,000 tons of coal to this state annually. The Annuaria Statistico states that the fuel resources of Italy comprise a few beds of anthracite coal of very limited area, and some beds of lignite of tertiary eocene and miocene age. These are found at Valdegno, near Vicenza, Grosseto, Murlo, near Siena, Sarzana, near Spezia, St. Giovanni, near Florence Candino, near Bergamo, and at Gonnesa, on the southwestern coast of Sardinia. There are also considerable deposits of peat at the foot of the Alps, of which over 90,000 tons are annually raised. In Spain

mining for coal dates from 1742, but the output until 1825 was trifling. There is a true bituminous coal and a lignite. The supply is obtained in Leon, Castile, and the Asturias, and the coal producing area is about 3501 square miles; the output is about 750,000 tons.

The coal basins of Sweden are few and far between. There are, in fact, only two districts where coal is found, the principal one being in the southerly province of Skania, and particularly in that portion of the province which forms the government of Malmohus. The other coal district is in the neighborhood of the village of Engelholm, on the borders of the province of Christianstadt, but it is possibly only an extension of the former, both belonging to the Triassic or Jurassic age. The total output is about 90,000 tons. The Hoganas is the oldest and most important basin, and contains 3 principal beds of different qualities, but none of them approaching a first-class coal. They are not well-adapted for coking, which is unfortunate, considering the extent and value of the Swedish iron trade. Coal mining in Russia has not yet met with any great attention from the amount of wood yet available. The supply of mineral, however, is something enormous, and calculations have been made showing a supply equal to possible demands for thousands of years.

The German Empire, as now consolidated, is one of the largest coal producers in Europe. Since 1870 the Empire includes old Prussia, Saxony, Bavaria, and the States of the Zollverein. The product of coal of all kinds in the whole of the German States amounts to something like 50,000,000 tons annually. The grand total of the output in 1871, when the consolidation of the Empire was completed, was 37,852,464 tons of 2204 lbs. Of the quantity now sent out of the pits Prussia is to be credited with 89 per cent. In Austria coal mining dates back to the year 1550. In 1819 it had amounted to 94,607 tons; in 1825 to 154,944 tons; in 1830 to 211,298 tons; 1835 to 250,782 tons; in 1840 to 469,212 tons; in 1845 to 721,707 tons After this date the lignite and coal are separated, and in 1878 they raised 5,500,000 tons of coal, and 9,000,000 tons of lignite.

The total area of the Indian coal fields is estimated at upwards of 30,000 square miles, the largest but three in the world—United States with 500,000 China 400,000, and Australia with 240,000. In India the amount of coal raised varied a good deal from year to year with a supply of seaborne coal in the market, the latter depending very much on the amount of tonnage available. The supply of coals which had been imported from Australia to India during the last 20 years had now dwindled down to almost nothing. The Indian coals are inferior to English and Australian, although they accomplish good work in locomotives; and but for the expense of land carriage no doubt they would be employed to the exclusion of all foreign seaborne coal.

The consumption in British India per annum in locomotives and factories is stated by one authority as being at present one million tons, of which one half was raised from Indian mines, the remainder coming from England, France, and Australia. Other authorities give four millions as the production of native coal.

One of the most important coal-producing countries of the globe is New South Wales; the trade has sprung up within a very few years, and the outlook for the trade is most encouraging, as the coal has been found equal to the English steam coal, and adopted by the Home Government. The approximate area of the coal fields is 24,840 square miles; the production from the opening of the mines up to 1874 amounted to 12,387,279 tons. In 1878 the production was 1,550,000 tons. In 1879 Nova Scotia produced 688,626 tons, being a slight decrease from the preceding year. The coal area of Vancouver Island is estimated at 390 square miles, and the output in 1879 228,974 tons.

Japan from its location may play an important part in the coal trade of the world. There are some 79 seams, but only 10 are more than three feet thick, and at the same time of good quality: nine others of more than three feet in thickness, of poorer quality, may prove workable if it should only require care in mining to separate much of their slaty matter. Besides these there are ten beds of coal between two and three feet thick which may be considered of workable character within the long period of time it will take to exhaust even the better beds.

The production in 1874 was stated at 396,240 metric tons, and for 1875 at 436,826 tons. We make an estimate of 600,000 tons for 1879. Skilled artisans and machinery have been taken from France to Japan to erect and work a factory for the manufacture of fuel out of coal dust.

There is a completely organized geological survey under Mr. B. S. Lyman who has estimated that the coal fields of Western Japan contain 620 million tons of coal, or 400 millions that could be extracted; China is in possession of coal deposits which are a surprise to the Europeans.

Coal was worked 2200 years ago at least. The anthracite basin of Southern Shan-se is so rich that an output of 300 million tons per annum would be available for 2400 years. The annual product is now set down at 3,000,000 metric tons, of which 1,000,000 is anthracite. Further discoveries of anthracite coal are reported in this country. The coal is stated by the Shanghai *Courier* to be the same as the best American anthracite that is brought to China.

The supply would appear to be of great extent, and the new coal has shown itself superior to all other known varieties for smelting purposes.

The coal in Chili is of a lignitic character, and amounts to a yearly business of 400,000 tons, of which 50,000 tons are exported. On the contrary 125,000 tons are imported from Great Britain.—London *Mining Journal*, *June* 26.

The Relative Cost of Motive Power.

Mr. Bissinger, M.E., at Carlsruhe, Germany, gives the following results as obtained in his examinations of the several motors in regard to the relative cost per horse power for each hour. It will be observed that the examination pertained principally to small motors.

The relative cost per effective horse power per hour is about as follows—

100	horse power	steam engine	7.6
2	"	"	44.3
2	"	Lehman's caloric engine	26.5
2	"	Hock's motor	40.0
2	"	Otto and Langen gas engine	26.4
2	"	Ott gas engine	26.4
2	"	Schmidt's hydraulic motor, supplied with water from the city water works	95.0
2	"	obtained by horses and a gin	45.0
2	"	obtained by manual labor	200.0

Otto's gas motor and Lehman's caloric engine are the cheapest of the small motors, but are, nevertheless, four times as expensive as the 100 horse power steam engine.—*Sci. Am.*

Fire and Waterproof Paper.—Mix one third of ground asbestos fibre with two-thirds of paper paste in a solution of common salt and alum. Pass the mixture into a machine, plunge the paper thus made into a bath of dissolved gum lac and send it through the finishing rolls, when it may be cut into sheets. The salt and alum increase the strength of the paper, and its resistance to the action of fire. The lac renders it impermeable to moisture, without interfering with its fitness for the reception of ink.—*Les Mondes.*

Correspondence

[The Journal is not responsible for the opinions expressed by correspondents.]

Carbonic Oxide in Water Gas.

Jersey City, July 6th, 1880.

Mr. Editor: I have read the various articles that have been presented to your readers from a number of correspondents asking and answering questions as to the subject of gas poison resulting from inhaling water gas, and must admit that it seems to me there can be no question as to the relative poisonous properties of ordinary coal gas and the water gas. It is but a short time since the daily press announced the sudden death, in New York city, of a very distinguished and accomplished man, M. Tessie du Motay, whose name was so closely identified with one of the leading water gas processes. His ability as a scholar and scientific man, together with his personal experience as the inventor of the Du Motay process, should certainly render his opinion upon this subject of some value.

It being my fortune to meet him quite frequently, we have more than once conversed upon gas matters, and my object in this letter is to record a fact in this connection which would tend to show very clearly that no one was more fully aware of the character stamped upon the gas made by his process, by the presence of the large amount of carbonic oxide which it contains, than the inventor himself.

In the course of a talk with him not more than three months before he died he remarked, in a thoughtful way, "This large amount of carbonic oxide is very objectionable—very." But, continuing the subject, he informed me that he was then engaged in study for devising a process by which the carbonic oxide would be entirely eliminated; and he remarked that, perhaps, by September he would have it perfected. But, alas! He has passed away, without a moment's warning, and the world is deprived of his mind and will in the great work of cheapening and improving gas manufacture.

While it may be doubted very much if he would have accomplished the great desire he seemed to have of removing this "*very objectionable*" element in water gas, yet it may some day be done; but until then it would seem foolish to deny that carbonic oxide is "very objectionable."

C.

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Germany—B. WESTERMANNS & Co., of New York

FRIDAY, JULY 16, 1880.

Official Report of Examinations of Gas for two Weeks ending July 10, 1880, made at the Photometrical Room of the Department of Public Works.

Corrected Illuminating Power.

June. 1880.	Time of Day at which Test were made.	New York Gas Light Co.	Manhattan Gas-Light Co.	Mutual Gas-Light Co.	Metropolitan Gas-Light Co.	Harlem Gas-Light Co.	Municipal Gas-Light Co.
		†	*	†	‡	*	†
28	Between	23.79	18.74	28.21	22.30	18.59	24.24
29		23.52	26.70	26.39	22.01	19.36	24.88
30	9.30 A.M.	23.91	19.70	26.90	21.15	18.22	25.54
July 1	and	23.62	18.07	27.69	20.60	19.08	23.24
2	1 P. M.	22.87	19.20	27.37	21.01	18.70	23.36
3		23.34	19.52	27.44	21.13	18.89	23.53
	Average	23.51	19.32	27.33	21.36	18.80	24.13
5							
6		22 36	18.73	25.82	——	18.01	24.49
7		24.07	18.45	27.17	20.96	18.03	24.18
8		24.14	18.41	27.03	21.26	17.68	25.10
9		24.65	18.76	26.86	21.41	18.11	24.79
10		24.86	18.87	27.62	21.75	18.33	23.21
	Average	24.01	18.64	26.90	21.34	18.03	24.35

* Five foot lava tip with check.
† Bray's slit union, No. 7.
‡ Bray's slit union, No. 6.

E. G. LOVE, Gas Examiner.

Compression of Gaseous Mixtures.

If five volumes of carbonic acid and one volume of air are compressed in a proper apparatus the carbonic acid readily liquefies. If the pressure is carried to 150 or 200 atmospheres the meniscus of liquefied acid is gradually effaced, and the liquid finally disappears. The tube then appears filled with a homogeneous matter, which resists all further compression, as a liquid would do. If the pressure is then gradually diminished the liquid suddenly reappears, at a pressure which is constant for fixed temperatures; a thick mist arises, vanishes in a moment, and marks the level of the liquid which has reappeared. The phenomenon cannot be explained by the heat of compression, for the tube is plunged in water which keeps it at a constant temperature, and the compression is made slowly enough for the cooling to be always complete. Cailletet thinks that the gas and liquid are multually dissolved, so as to form a homogeneous compound. He has extended the experiments to a pressure of 450 atmospheres without varying the result.—*Comptes Rendus.*

The Electric Light at Montreal.

The experiment of lighting the wharves by the electric system for 30 days is now nearly expired, and it will therefore be necessary to arrive at a final decision in a few days. The amount of light obtained has not been up to the quantity promised, but it is a vast improvement on that hitherto provided.

The cost of running the 16 lights is estimated, after careful computation by the chief engineer, from practical results during the present trial, including wear and tear, interest on capital, and running expenses, at about 8 cents per hour per lamp. Assuming that they are kept burning 10 hours per night on an average, and 200 nights in the season, would give 80 cents per night, or $160 per season per lamp, and $2,560 in all for the 16 lamps for the season. The machinery seems to work well, and there has been no special trouble in the work being performed.—*Montreal Gazette.*

The Largest Coke Works in the United States.

The largest coke works in the United States are the Morewood Works of H. C. Frick & Co., which are situated a mile or so west of Mt. Pleasant, in the great coal district of Western Pennsylvania. These works are as yet uncompleted, but a short time will see them finished and in full operation. At the present writing the works consist of two shafts and 200 ovens in active operation, and over 1000 acres of coal land. The shafts are distinguished as upper and lower, and are about half a mile apart. But in this short distance the vein of coal dips to such an extent that there is a difference of 71 feet in the distance that the coal has to be raised to the level of the tipple. At each of the shafts there are two large engines of 50-horse power. The ovens have a capacity of about 300½ tons of coke each per day, and make about 25 cars of coke per day. When the works are completed there will be 500 ovens in blast, and the product will be increased to 80 cars of coke per day. It will require to make this output the services of 500 men.—*Iron Age.*

Prices of Gas Coal.

The following are the prices at which the companies mentioned are shipping coal:

	New York.	Baltimore.	S. Amboy
Penn	$5.25	$4.10	$4.80
Scott's Youghiogheny	5.00	3.75	
Montauk	5.00	3.70	
Newburgh Orrel	5.00	3.75	
Tyrconnell	5.00	3.75	
Despard	5.00	3.75	
West Fairmount	5.00	3.75	

To give some idea of the relative prices at the East and the West we give the following quotations of coal furnished by the Fort Pitt Coal Company:

At Pitsburgh, f.o.b. cars	$1.30	per ton of 2000 lbs.
At Cleveland, f.o.b. cars	2.90	" "
At " f.o.b. vessels	3.05	" "
At Buffalo, f.o.b. cars	3.55	" "
At Chicago, f.o.b. cars	3.60	" "
At Indianapolis, f.o.b. cars	3.00	" "

Gas Stocks.

Quotations by G. W. Close Jr., Broker and Dealer in Gas Stocks.
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JULY 16, 1880.

☞ All communciations will receive particular attention

☞ The following quotations are based on the par value of $100 per share. ☜

	Capital.	Par.	Bid.	Asked.
Gas Co.'s of N. Y. City.				
Central	466,000	50	60	70
Harlem	1,800,000	50	70	75
" Bonds	170,000			103
Manhattan	4,000,000	50	187	192
Metropolitan	2,500,000	100	140	147
" Scrip	$1,000,000	..	100	103x
Mutual	5,000,000	100	75	80
" Bonds, gold	900,000	1000	100	—
Municipal	1,500,000	100	160	170
" Bonds	750,000		106	110
New York	4,000,000	100	100	102
Northern	270,000	50	—	100
Gas Co's of Brooklyn.				
Brooklyn	2,000,000	25	110	120
Citizens	1,200,000	20	60	65
" S. F. Bonds.	320,000	1000	100	105
Fulton Municipal	1,500,000	100	70	80
Peoples	1,000,000	10	38	42
" Bonds	290,000	...	90	95
" Scrip	250,000	...	75	85
Metropolitan	1,000,000	100	65	75
Nassau	1,000,000	25	50	57
" Ctfs.	700,000	1000	85	95
Williamsburgh	1,000,000	50	70	75
" Scrip		...	98	103
Kings Co	135,000	100	60	70
" Bonds	40,000	—	—	—
Union Co. E. N. Y.		25	—	50
Richmond Co., S. I.	300,000	...	75	80
Out of Town Gas Companies.				
Bath, Maine	70,000	100		
Buffalo Mutual, N.Y	750,000	100	65	70
" Bonds	200,000	1000	95	100
Baltimore, Md.	2,000,000	100	185	190
" Ctfs., gold	1,000,000		—	103
Bayonne, N. J.		100		90
Brockport, N. Y.	25,000	100	...	80
Citizens, Newark	918,000	50	85	90
" " Bds.	124,000	—	105	10
Chicago Gas Co., Ills			125	—
Cincinnati G. & C. Co.				190
Derby of Conn	160,000	100	60	80
East Boston, Mass		25	114	120
Elizabethtown, N. J.	300,000	20	—	130
Fort Wayne, Ind.		100	...	—
Hannibal, Mo.	100,000	100	95	100
Hartford, Conn.	700,000	25	120	125
Hempstead, L. I.	25,000	100	...	—
Halifax N. S.	400,000	40	148	150
Hamilton, Ontario	150.000	40	117½	
Jersey City	750,000	20	155	160
Jamaica, L. I.	25,000	100	...	—
Jacksonville, Ill.	120,000	50	100	...
Lewistown Maine	400,000	100	70	80
Laclede St Louis Mo.	1,200,000	100	93	96
Long Branch		20	30	40
New Haven, Conn		25	120	140
Peoples, Jersey City		...	50	60
" " Bds.				5
Peoples of Baltimore		25	100	102
" Bonds			106	—
Plainfield, N. J.	80,000	100	—	105
Perth Amboy		25	—	95
Pittsfield, Mass.			120	130
Rochester, N. Y.		50	70	80
" Citizens		100	50	60
Rondout & Kingston			75	80
St. Louis Missouri	600 000	50	300	—
Stillwater, Minn.	50,000	50	—	26

Saugerties, N. Y	15,000	100	95	100
San Francisco Gas-Co., S. Fr'isco Cal.			82	83
Toledo. Ohio.....			95	97
Troy, Citizens..	600,000	100	—	—

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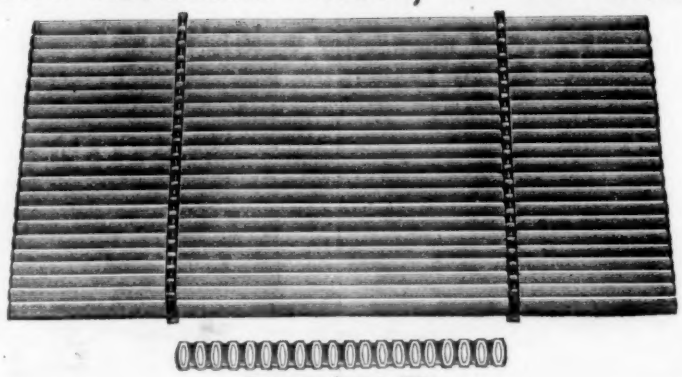

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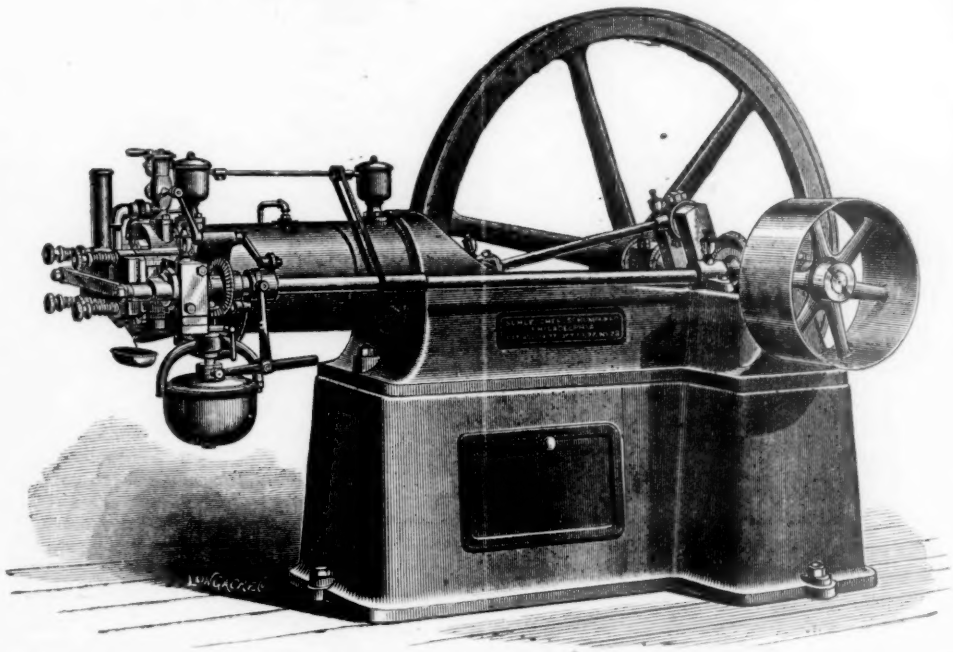

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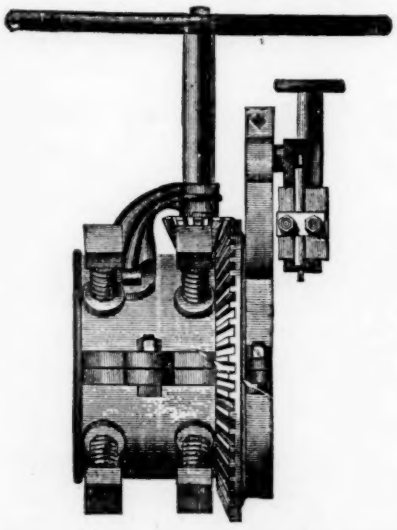

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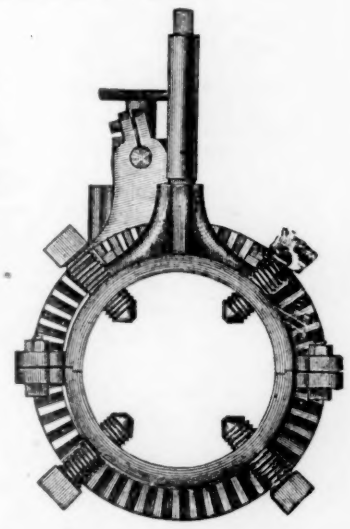

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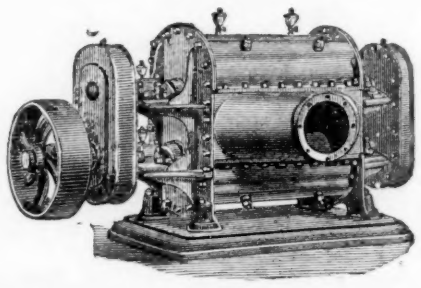

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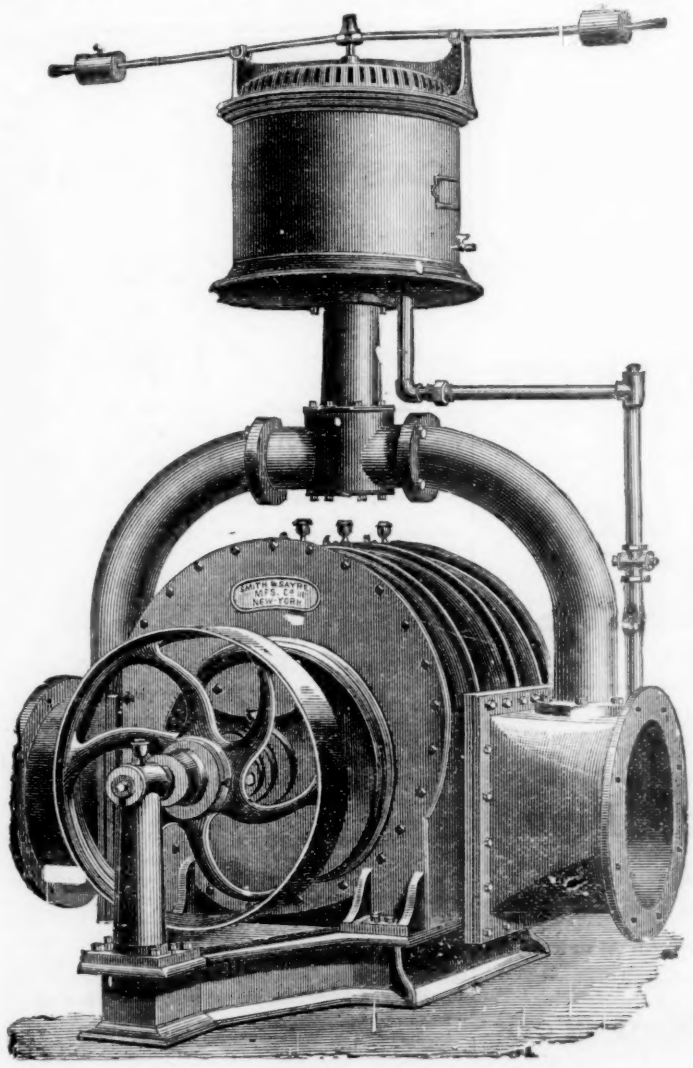

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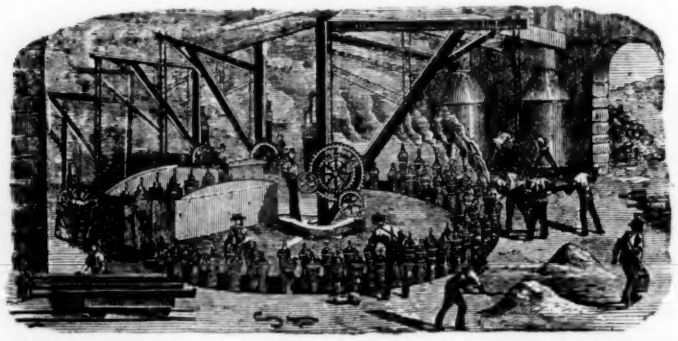

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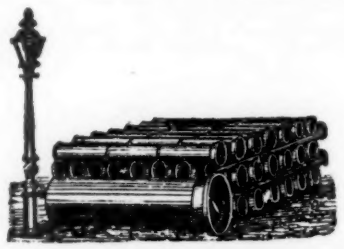

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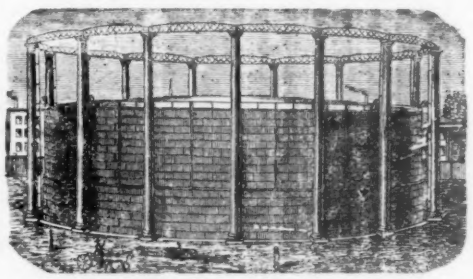

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351-1y

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Attest—J. L. CAMPBELL, Secretary, pro-tem. Signed—A. T. GOSHORN, Director General J. R. HAWLEY, President.

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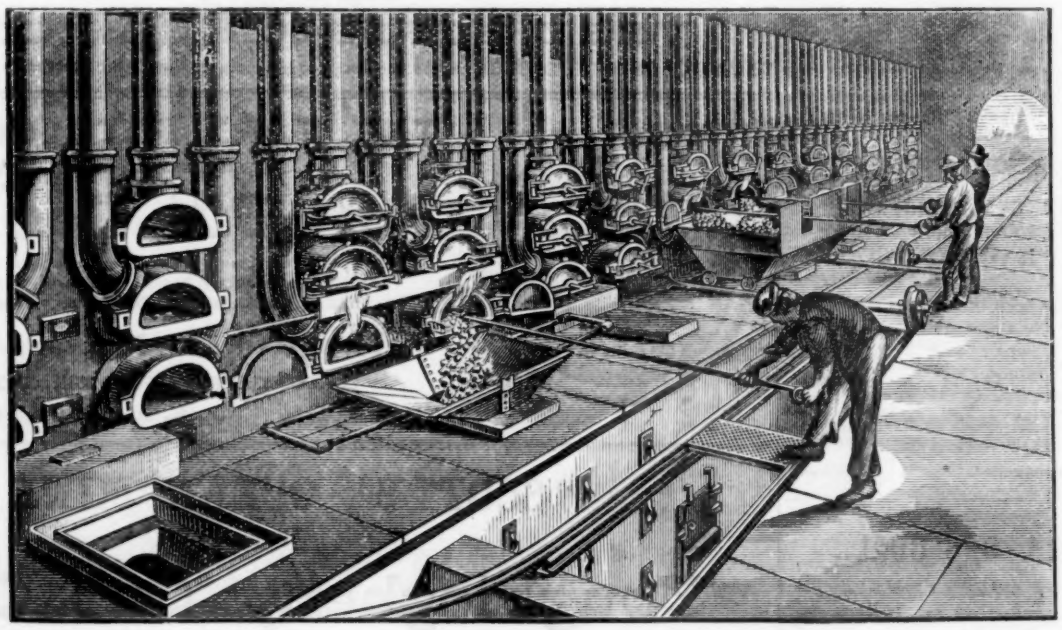

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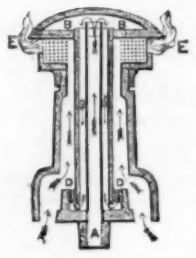

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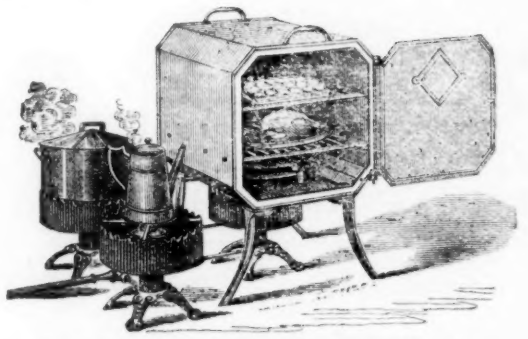

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